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NATIONAL MUSEUM MELBOURNE

Vol. XXII. Part 7.

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The Journal of the Department of Agriculture of Victoria, Australia.

July, 1924.

PRINCIPAL CONTENTS

Wheat and its Cultivation

The Production and Flue-Curing of Tobacco

Mediterranean Fruit Fly

Potato Manuring Trials

Poultry Feeding Experiment

Tomato Diseases

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OF

THE DEPARTMENT OF AGRICULTURE,

VICTORIA, AUSTRALIA.

NATIONAL MUSEUM MELBOURNE

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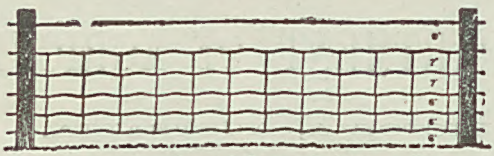

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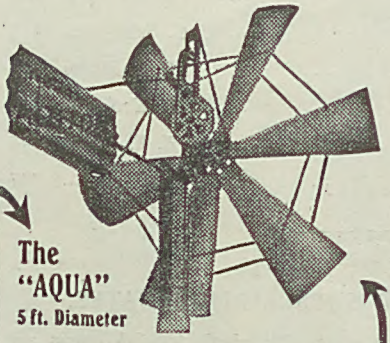

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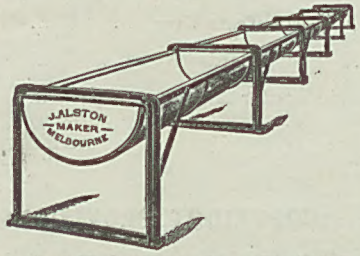

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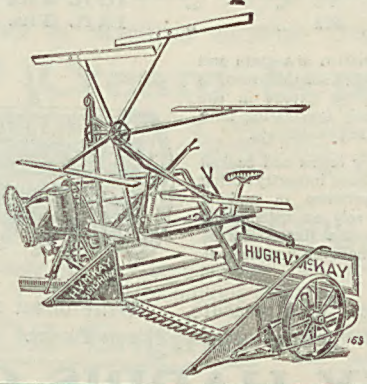

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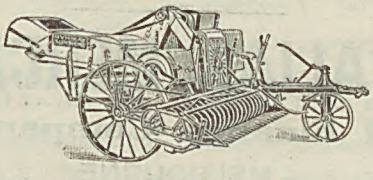

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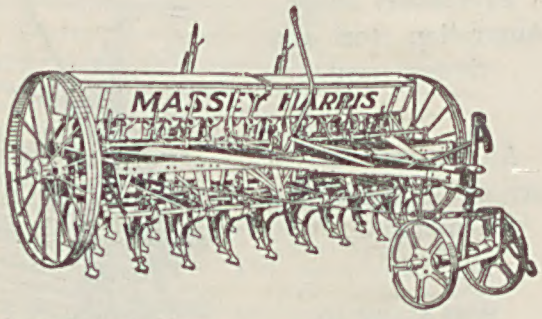

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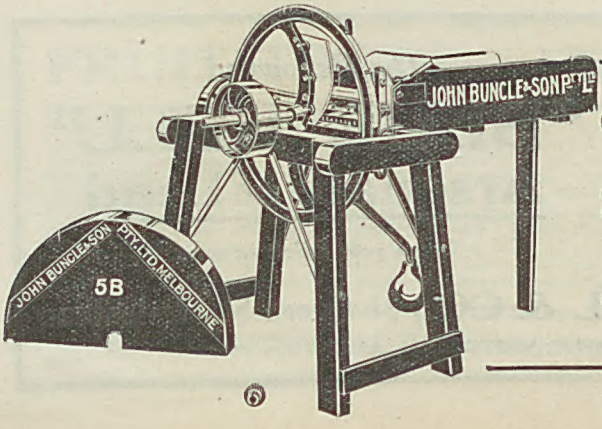

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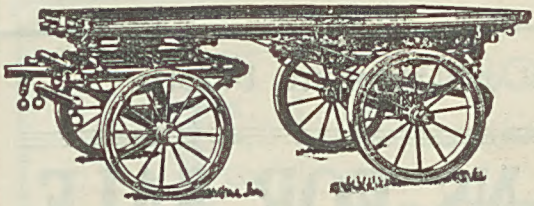

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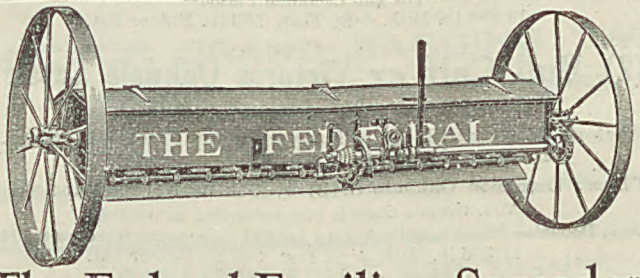

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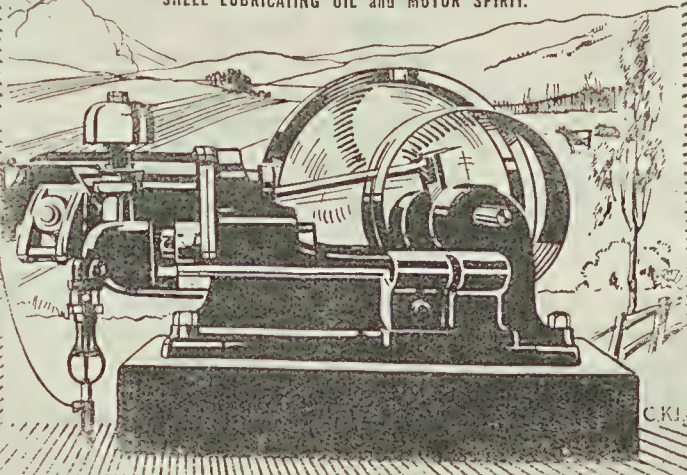

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NATIONAL MUSEUM MELBOURNE

WHEAT AND ITS CULTIVATION.

(Continued from page 281.)

By A. E. V. Richardson, M.A., D.Sc., Agricultural Superintendent.

A modification of the three-course rotation—wheat, pasture, bare fallow—may be used in the more favoured wheat areas. The year of pasture may be replaced by an oat crop grown for hay, grain, or for grazing. This rotation, wheat; oats; bare fallow, implies that each year two-thirds of the arable area of the farm will be regularly cropped, and the remainder fallowed.

In the wheat areas enjoying the best conditions, oats thrive well after wheat, and the growing of oats after the wheat stubble fits in well with the management of the farm. The wheat stubble is usually burnt at the first favorable opportunity, and the land either disced, cultivated, or ploughed, according to the nature and condition of the soil. The harrows may be used to prepare a seed bed, but frequently the wheat-grower dispenses with harrowing and sows with a combine drill.

Oats do not suffer from "malting" to the same degree as wheat. Wheat has a "naked" seed, and if the grain lies for some time on a comparatively dry seed bed the germination is often impaired by "malting." The soil may contain sufficient moisture to start the seed germinating, but insufficient to maintain the young plants till the winter rains thoroughly moisten the soil. The seed of oats is protected by a dry husk, and it will lie in a dry seed bed for some considerable time without injury.

The problem of the best method of growing oats after wheat stubble might well be made the subject of critical field experiments in various parts of the wheat belt.

The oat crop may be grazed by sheep or cut for hay or grain. If cut for hay, it is usually harvested and stacked before the wheat harvest is in full swing.

The cost of growing oats on stubble land is generally small, and the returns in normal and good seasons are very profitable. In dry years, however, the crop will be exceedingly light.

Wheat-growers do not give the oat crop any special cultural treatment. It is simply regarded as a means of supplying at low cost, either the hay necessary for the farm, seed for the following year, or winter grazing for the sheep and lambs. Wheat—the cash crop—is the main source of revenue, and experience has shown the necessity of thorough preparation for it. Hence oats have come to be regarded as a side line, though there is no doubt that the crop would respond to more liberal treatment. Wherever in the wheat belt oats have been sown on well-cultivated and liberally fertilized fallows the response has been very gratifying.

In the drier parts of the wheat belt the rotation suggested cannot be followed on the whole arable area. Instead of sowing the whole of the stubble with oats, it may be practicable to regularly sow one-half the area of stubble with oats and leave the remainder in the normal Mallee rotation, i.e., wheat, pasture, bare fallow. In this case the distribution of cropping on a 640-acre farm would be approximately as follows:—Wheat, 200 acres; oats on stubble, 100 acres; pasture, 100 acres; bare fallow, 200 acres.

Assuming such a farm subdivided into six paddocks, the succession of cropping in any one paddock would be:—Wheat; oats; bare fallow; wheat; pasture; bare fallow.

Another rotation frequently practised on larger holdings is as follows:—Wheat; oats; pasture, bare fallow. This is the so-called Wimmera rotation, but it is not as extensively used in the Wimmera as is commonly supposed. It implies that on an average only one-quarter of the farm is sown with wheat each year, one quarter with oats, and that the remaining portions of the farm are in bare fallow and grass. Such a rotation enables a considerable number of sheep to be kept, especially where portion of the oat crop is grazed.

There is little doubt that under this scheme of rotation the organic content of the soil could be indefinitely maintained, especially when the oats are regularly grazed with sheep. Labour is reduced to a minimum, and the number of sheep that can be kept is considerable.

For high-priced Wimmera land, however, the cropping may not be regarded as sufficiently intensive. In the higher rainfall areas, e.g., Western District and Gippsland, the wheat-grower has a wider range of crops with which to construct a satisfactory rotation. Oats, barley, peas, rape, may be worked into the rotation as circumstances permit. Even bare fallowing may be replaced by a green crop fed down by stock without unduly lowering the wheat yield.

It may be said that in regions with an annual rainfall of over 20 inches, a fairly intensive cropping programme is possible, in wh wheat may be grown in rotation with oats and a forage crop—rape, peas or barley—fed down by sheep. In portions of the Western District, spring-sown rape does well, and affords splendid fattening feed for sheep. The ploughed-in residues of the rape make a suitable seed-bed either for oats or wheat, especially in seasons with liberal winter rains.

It has already been stated that the fundamental weakness of alternate cropping and bare fallowing is that the system leads to the depletion of the organic content of the soil. The feeding of forage crops with sheep provides a means of arresting the depletion of organic matter

The growth of forage crops for feeding down with sheep may be profitably undertaken in the Western District and the wheat areas of Gippsland, for these areas enjoy a liberal winter rainfall, and conservation of soil moisture is of far less importance than in the drier areas north of the Divide.

Origin of Crop Rotations.

The idea of growing crops in rotation was familiar to the Romans, for both Vergil and Cato describe the advantages of alternating grain culture with legumes. The systems of rotation in Northern Europe were the result of the scheme of land tenure common in the time of the village communities. When the village had control of the land, the fields were unenclosed instead of being divided up into farms. The fields were cultivated by many individuals, each working for himself on a separate piece of land allotted for a single season. To avoid conflict of interests the large fields were divided into three parts, one of which was devoted, one year in three, to winter grain (wheat and rye), another to summer grain (barley or oats, sown in the spring), whilst the third was fallowed. The fallow fields were used for pasturage during the year, and the others for grazing after harvest.

This was the old three-course system of rotation practised in Northern Europe. Individuals were not allowed to deviate from the established practice. When centuries later the tenant system of farming began, the landlords compelled their tenants to adhere to the customary rotation.

The scheme was simple and well adapted to a primitive state of society, but was unsuited for a scattered population living on separate farms, and was not suitable for stock farming. Thus the primitive system of rotation became modified, and fodder crops were gradually introduced. Crop rotations began as a social necessity, and tradition has been responsible for their continuance.

How to Determine Suitable Rotation Systems.

The type of rotation best suited to a given climate and soil region may be determined in two ways—

(1) By the accumulated experience of generations of farmers.
(2) By direct experiment.

In a country in which agriculture has been practised for centuries, the accumulated experience of generations of farmers gradually brings into use a system of farming highly adapted to the soil and climatic conditions of the region. The farmers try various combinations and successions of crops, and ultimately the methods of those who consistently secure the highest returns become adopted by the majority.

In England a large number of rotation systems is in vogue, highly adapted to specific soil and climatic regions. In a new country, where farming has not been in progress long enough to establish such systems of farming by tradition, a quicker and more direct method of determining suitable rotation systems is desirable. Such is the establishment of a system of permanent rotation plots.

An effort has been made at Longerenong and Werribee to determine experimentally the value of different systems of rotation cropping for the respective districts. At Longerenong, eight different systems of cropping have been tested since 1917 on a uniform area of Wimmera grey soil.

The crop rotations were: (1) wheat grown continuously, (2) wheat after bare fallow, (3) wheat, pasture, bare fallow, (4) wheat, barley, peas, (5) wheat, oats, peas, (6) wheat, oats, bare fallow, (7) wheat, oats, pasture, bare fallow, (8) wheat, rape, barley, peas. The plots are permanent, and the object of the test is to determine the effect of each system of cropping on the yield of the main crop—wheat—and the influence of each system of rotation on the fertility of the soil.

These plots will provide, in years to come, definite information as to whether the productive power of the soil is being increased, sustained, or depleted under these varying systems of farming.

The best rotation for the Wimmera will be the one that continues to give the best financial returns over a long period without impairing the fertility of the soil.

With each system of rotation there were the same number of plots included as there were years in the rotation. Hence results are obtained of the yield of every crop for each year the experiment has been conducted.

The yields of wheat for six years (1918-1923) are as follow:—

TABLE SHOWING AVERAGE YIELD OF WHEAT GROWN UNDER VARYING SYSTEMS OF CROP ROTATION IN THE WIMMERA FOR SIX YEARS (1918-1923).

Crop Rotation.	Plot Nos.	Yield for 1923.	Average yield for 6 years.
		bush. per ac.	bus. per ac.
A. Wheat grown continuously ..	1	11.23	11.17
B. Wheat after bare fallow	2, 3	40.23	34.03
C. Wheat, pasture, bare fallow ..	4, 5, 6	39.43	35.52
D. Wheat, barley, peas	7, 8, 9	41.3	30.79
E. Wheat, oats, peas	10, 11, 12	42.8	30.34
F. Wheat, oats, bare fallow	13, 14, 15	46.63	38.05
G. Wheat, oats, pasture, bare fallow ..	16, 17, 18	47.63	37.08
H. Wheat, rape, barley, peas ..	19, 20, 21, 22	44.56	31.53

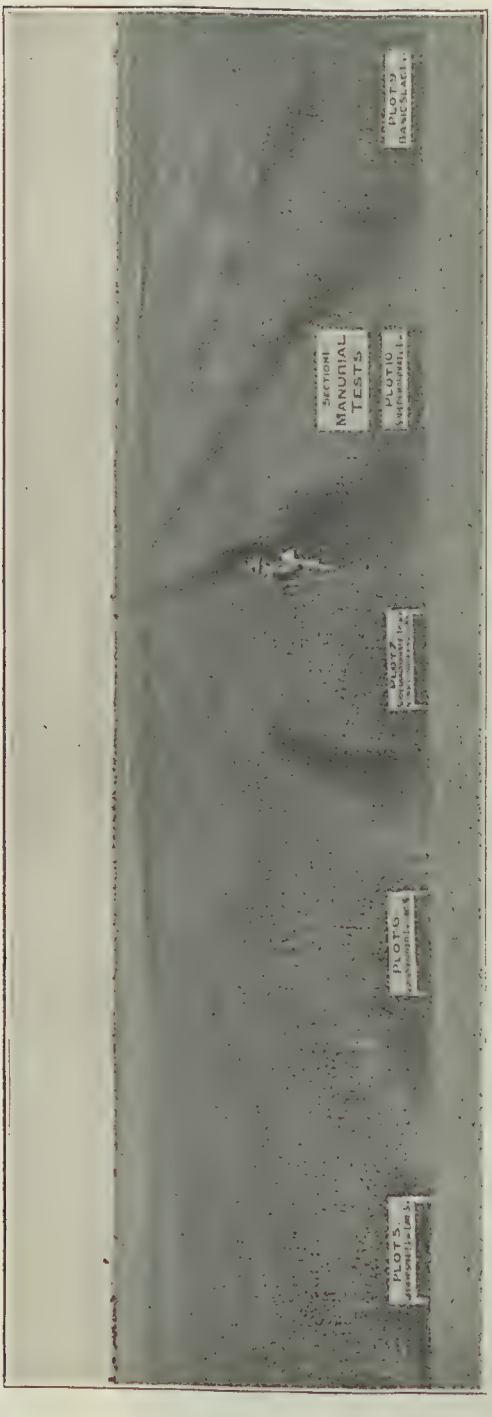
The systems giving the highest yields of wheat throughout the period were—

1. Wheat, oats, bare fallow, 38.05 bushels.
2. Wheat, oats, pasture, bare fallow, 37.08 bushels.
3. Wheat, pasture, bare fallow, 35.52 bushels.
4. Wheat after bare fallow, 34.03 bushels.

The highest yields were obtained when oats were included in the rotation and a bare fallow preceded the wheat crop.

The effect of including a winter fodder crop, such as peas, in the rotation during the year preceding the wheat crop, was to lower the yield of the subsequent wheat crop. This may perhaps be regarded as somewhat surprising to those unfamiliar with the special requirements of the Wimmera.

The growth of a leguminous crop such as peas in a rotation with wheat might be expected to have increased the nitrogen content of the soil, and to have made the soil more fitted for the growth of a good wheat crop. The peas were either fed off with sheep or cut for hay, as circumstances at the time dictated, and the crop residues were immediately turned in and the land treated throughout the summer as



View of Permanent Manurial Tests, Longerenong.

a bare fallow. In regions of heavy rainfall, the growth of a leguminous crop during the winter preceding the sowing of the wheat crop would undoubtedly have resulted in a yield of wheat at least equal, and possibly superior, to that grown on bare fallow. It is obvious, however, that under Wimmera conditions, despite the addition to the soil of nitrogenous organic matter from the residues of the pea crop, the yield of wheat has been decreased by the growing of peas during the year preceding the wheat crop.

The average yield of the four cropping systems (B, C, F, G) in which bare fallow preceded wheat was 36.2 bushels, whilst the average yield of the three rotations in which peas preceded wheat was 30.9 bushels. Thus the growth of peas has depressed the wheat yield by 5.3 bushels per acre.

We are not at the moment concerned with the question as to whether the value of the pea crop does not greatly exceed its cost of preparation, plus the value of the 5.3 bushels of wheat. The important lesson from the experiment is that at present conservation of moisture by bare fallowing has a more important influence on wheat yields in the Wimmera than the addition of nitrogen and organic matter to the soil through the growth of a leguminous crop.

Permanent Rotation Plots, Werribee, showing growth of oats on (1) plot continuously cropped with oats, and (2) oats grown on bare fallow.

As already stated, in regions of heavy rainfall, *e.g.*, over 21 inches, the influence of peas on the yield of the succeeding wheat crop would be much more marked, because in these regions leaching of nitrates is considerable, nitrification is much less active than in the Wimmera, and conservation of soil moisture is far less important than in a semi-arid area.

Of the four rotations that include a bare fallow, rotation 3—wheat alternated with bare fallow—has given the lowest yield of wheat. It does not necessarily follow that it would be the least profitable rotation to practise. With the prices ruling for wheat during the war, such a rotation would have been highly profitable, for one-half of the arable area of the farm would be in crop each year. Such a system of cropping, however, prevents the farmer from keeping sheep.

Now that prices of wheat have materially fallen, and prices of wool and sheep have advanced, the rotations which permit the association of a flock of sheep with the growing of wheat will be more profitable.

The continuously cropped plot gave an average yield of 11.17 bushels over the whole period, as compared with 34.03 bushels from the wheat after bare fallow.

If 400 acres of similar land had been continuously cropped throughout this period it would have produced a gross yield each year of 4,492 bushels. If the same area had been alternately fallowed and cropped, then the 200 acres sown to wheat would have yielded annually 6,806 bushels. Thus the bare fallow wheat rotation would have given 51 per cent. more wheat per farm, and at a far lower cost of production, for the seed and manure bill would be reduced by one-half, and the cost of harvesting 200 acres of bare fallow would be much less than that of the 400 acres of continuously cropped land.

That wheat can be grown continuously, and that high yields per acre can be maintained indefinitely, has been demonstrated at Rothamsted. By liberal manuring of the crop with nitrates, phosphates, and potash, the yield of wheat on continuously cropped land has been maintained at a high level for 80 years. The rainfall at Rothamsted is 27½ inches per annum.

In the Wimmera no combination of artificial fertilizers can make up for deficiency of soil moisture. On a rainfall of 17½ inches bare fallowing is an indispensable preliminary to successful wheat culture, and the extra moisture conserved by fallowing influences wheat yields to a greater degree than does any combination of artificial manure. As a matter of fact, the average return for a period of twelve years from the unmanured plot at Longerenong is 34 bushels per acre, as compared with 11.17 bushels per acre from continuously cropped land which received an annual application of 1 cwt. of superphosphate.

The results from the rotations in which barley or oats followed the wheat crop are of interest.

Table Showing Average Returns of Oats or Barley Grown in Rotation with Wheat, for Seasons 1918-1923—Longerenong.

Rotation.	Average yield of crop throughout period.	
	Wheat.	Oats or Barley.
	bus. per acre.	bus. per acre.
D. Wheat, barley, peas	30.79	20.1 (Barley)
E. Wheat, oats, peas	30.34	24.4 (Oats)
F. Wheat, oats, bare fallow	38.05	26.5 (Oats)
G. Wheat, oats, pasture, bare fallow	37.08	26.8 (Oats)
H. Wheat, rape, barley, peas	31.53	44.7 (Barley)

The average return for the period for barley grown on wheat stubbles at Longerenong is 20.1 bushels per acre.

The yield of oats grown on wheat stubbles does not vary much with the type of rotation, and averages about 25 bushels for the period. Oats, however, are less able to withstand dry years than barley. Thus during 1919 the oat crop sown on the stubbles of rotations E, F, G failed to mature, while the barley grown on wheat stubbles yielded 7.4 bushels, and barley grown after rape gave 22.9 bushels per acre.

It is interesting to note that, if we allow for the differences between the weight per bushel of barley and oats, the yield of cereal grain grown on wheat stubbles in the four rotations is practically the same, namely, about 1,000 lb. of grain per acre.

When barley is grown after a rape crop fed off (rotation H), the yield per acre for the entire period is 44.7 bushels.

Barley does exceptionally well on fallowed land at Longerenong. Thus, in the variety plots the yields have exceeded 70 bushels per acre during three of the past five years.

These rotation experiments were planned mainly to throw light on the problem of maintaining soil fertility in the Wimmera, and incidentally to determine how the yield of wheat is affected by growing it in rotation with the various crops that are raised in the Wimmera.

Many years must elapse before definite information will be available on the former problem, and it is desirable that twelve years' results should be available before a full discussion of the latter problem is possible, for twelve years is the shortest period in which the three and four-course rotations will have completed their cycles.

Permanent Rotation Tests at Werribee.

Tests have been conducted for ten years at Werribee to determine the yields of hay and wheat in various rotation systems. Four series of hay plots, and six series of wheat rotations, have been tested for ten years.

The results are as follow:—

TABLE SHOWING AVERAGE YIELD OF OATEN HAY AND WHEAT IN THE PERMANENT ROTATION PLOTS—STATE RESEARCH FARM, WERRIBEE.

Rotation.	Average yield per acre.
1. Hay grown continuously	24.1 cwt.
2. Hay after bare fallow	48.9 „
3. Hay, barley, bare fallow	50.2 „
4. Hay, barley, peas	34.5 „
5. Wheat grown continuously	7.0 bush.
6. Wheat, after bare fallow	17.1 „
7. Wheat, pasture, fallow	16.6 „
8. Wheat, oats, pasture, fallow	17.7 „
9. Wheat, rape, peas	16.0 „
10. Wheat, rape, barley, peas	13.9 „

The results demonstrate that when oaten hay is grown either after bare fallow or in a three-year rotation as hay, barley, bare fallow, the yield of hay is more than double that of the land growing hay continuously.

When hay is grown in a three-course rotation with peas and barley, the average yield is 34.5 cwt. per acre. The annual rainfall at Werribee is 20½ inches, but it is fairly evenly distributed throughout the year. That the yields of hay are considerably less after peas than after bare fallow suggest that the extra soil moisture conserved by fallowing is of more importance to the hay crop than the extra nitrogen gathered by the peas

The value of rotation in relation to hay production is further shown by comparing the yield of hay following peas and barley with that where hay is grown year after year. In both cases the land is under crop every year, but where crop rotation is practised an average yield of 34.5 cwt. per acre is obtained, against 24.1 cwt. for the plot continuously cropped with hay.

The average yield of barley in the rotation—bare fallow, hay, barley—was 30.4 bushels, whilst in the rotation hay, barley, peas, the average yield of barley was 28.7 bushels, and that of peas 10.2 bushels per acre.

A 200-acre Field of Wheat at Cowangie, grown on the Mallee Rotation System—Wheat, Pasture, Bare Fallow.

With the wheat plots the highest yield was obtained from the Wimmera rotation—wheat, oats, pasture, bare fallow—17.7 bushels per acre for a ten-year period. The yield of wheat after bare fallow was not far short of that from Wimmera rotation—namely, 17.1 bushels.

The Mallee rotation—wheat, pasture, bare fallow—yielded an average return of 16.6 bushels per acre. The inclusion of peas in place of bare fallow depressed the wheat yields, but not to the same marked extent as at Longerenong. This is probably owing to the higher rainfall at Werribee. Finally, the continuously cropped plot yielded only 7.0 bushels for the period.

Crop Rotation must be Supplemented by Soil Fertilization.

Before leaving the subject of crop rotation there is one important point to bear in mind. No system of crop rotation—however well conceived and carried out—can make up for either want of cultivation or manuring. Crop rotation is not a substitute for manuring, i.e., rotation of crops in itself will not maintain the fertility of the soil. *Crop rotation alone, without adequate manuring, will not increase, nor even maintain, the soil's fertility.* No system of crop rotation can add

one single pound of any of those *inorganic* elements so essential for plant growth. Moreover, unless legumes are grown, or unless they appear naturally in the pastures, even the nitrogen content will not be maintained. A rational system of crop rotation *does* increase the *organic* content of the soil, simply because the plant obtains its organic matter from the carbon dioxide of the atmosphere. Ninety-five per cent. of the dry weight of the plant is obtained from the air. When a crop is ploughed in as a green manure, or fed down on the land with stock, the soil is enriched by the organic matter which the plant has secured from the atmosphere. But no scheme of crop rotation in itself can add one iota to the *inorganic* portion of the soil. Rotation of crops must, therefore, be supplemented by the application of inorganic manures, if the fertility of the soil is to be maintained or increased. Nothing could be clearer on this fundamental point than the results obtained during the last 70 years at the Rothamsted Experimental Station. The results obtained in the Agdell field represent the world's best information on this point. In the Agdell field the Norfolk four-course rotation—turnips, barley, clover, wheat—has been practised for over 70 years. In any one year there were three plots for each crop, viz.:—

(1) Unmanured.
(2) Manured regularly with phosphates.
(3) Manured regularly with phosphates and nitrogen.

The following table shows very clearly that (1) on Section I., where rotation was carried on without soil fertilization, the yields in turnips, barley, and wheat have regularly and continually declined. After the first year the turnip yield on this plot never exceeded 3 tons per acre, i.e., they were always grown at a *loss*. The barley average dropped from 46.5 to 13.7 bushels, whilst the wheat dropped from 29.7 bushels to 18.9.

SUMMARY OF RESULTS OF CROP ROTATION IN AGDELL FIELD, ROTHAMSTED, SINCE 1848.

	Section I. Unmanured.			Section II. Phosphates.			Section III. Phosphates and Nitrogen.		
	Turnips.	Barley.	Wheat.	Turnips.	Barley.	Wheat.	Turnips.	Barley.	Wheat.
	lbs.	bush.	bush.	lbs.	bush.	bush.	lbs.	bush.	bush.
(1) First Crop, 1848	19,564	46·5	29·7	25,004	36·3	30	25,032	35·9	30·3
(2) Average of first 20 years ..	5,264	38·0	29·6	18,561	36·8	32·5	31,198	46·3	35·3
(3) Average of second 20 years ..	1,723	22·5	21·1	17,669	28·1	30·1	31,790	41·1	32·0
(4) Average of third 20 years ..	967	13·7	18·9	25,275	22·2	38·9	41,739	29·2	36·4

(2) On Section II. the application of phosphates has maintained the yield of turnips, and has increased the wheat yield by 25 per cent., while on the unfertilized plot the yield of turnips dropped to less than ½ ton per acre, the plot manured with phosphates has averaged nearly 12 tons per acre during the last twenty years. The barley crop shows a falling off, but it remains twice the average of the unfertilized barley crop.

(3) The turnip crop, on Section III., manured with phosphates and nitrogen, has increased from 12 tons to 20 tons per acre. The barley crop, which follows the turnips, seems to have suffered from the increased demands made by the heavy crops of turnips. The average yield, however, is more than twice that of the unfertilized plot. Finally, the high

initial wheat yield, 30.3 bushels, has not only been maintained throughout the whole 60 years, but has even increased during the last twenty years to 36.4 bushels. Soil fertilization is, therefore, bound up with crop rotation, and is indispensable for the maintenance of soil fertility.

MANURIAL PROBLEMS.

The most important requirement of a permanent system of agriculture is the maintenance of the productive power of the soil, and the permanent value of any given method of cultivation must be determined by its effect on soil fertility.

Under a good system of farming the soil will gradually increase in productive power. Poor soils may be improved, and rich soils made richer.

Bad methods of cultivation, however, will gradually deplete the soil of its fertility, and render rich soils incapable of producing other than mediocre crops.

Factors Involved in Soil Fertility.

Soil fertility, in practical language, is the cropping capacity—the productive power—of the soil. It is a complex of many factors—some external—some internal.

Obviously, the climate is the most important external factor, and the amount of rainfall, its seasonable distribution, the range of temperature, &c., are controlling influences in successful farming. Excluding these climatic considerations, however, as entirely beyond human control, we may say that the fertility of a soil is dependent on the *chemical*, *physical*, and *biological* nature of the soil. Let us consider these points seriatim.

Chemical Composition.—One of the most common characteristics of a fertile soil is that it contains, in a soluble or available form, a sufficiency of those elements necessary for the nutrition of plants. These are ten in number, namely—carbon, hydrogen, oxygen, nitrogen, sulphur, phosphorus, potassium, iron, magnesium, calcium (lime). The first three are obtained from the air and water, the remaining seven are obtained from the soil.

These elements are essential plant foods. Seven of these ten essential constituents are present in most soils in abundance. Three others—nitrogen, phosphorus, and potash—are frequently wanting or deficient. As the yield of the crop is governed by the amount of the most deficient element present, it is obvious that a study of the three substances referred to is of immediate practical importance. Lime sometimes becomes of considerable practical importance in assisting production, but the necessity for lime invariably arises from a faulty physical and biological condition of the soil or from the necessity for correcting soil acidity, and not because it is actually required for plant food.

In the case of the wheat crop (straw and grain), of the total amount of food taken in by the crop—

(1) No less than 93½ per cent. is obtained from the air and from the rain.
(2) 3½ per cent. consists of mineral substances with which the soil is abundantly supplied.
(3) About 3 per cent. consists of nitrogen, phosphoric acid, and potash, which the soil contains in strictly limited quantities.

Hence, that portion of the plant's needs which man may require to supply is only a small fraction of that which is yielded by crops. But it

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is an indispensible fraction, and on this simple fact rests the practice of manuring.

So far as chemical considerations are concerned, a fertile soil is one containing a sufficiency of plant foods—and particularly nitrogen, phosphoric acid, and potash—in an *available* or soluble form. Emphasis must be laid on the presence of available plant food, because the greater portion of the plant food is locked up in inert forms, i.e., in forms incapable of being used by the plant. While, therefore, a soil may contain large reserves of nitrogen, phosphoric acid, and potash, it may yet be unable to support the growth of a profitable crop. Such a soil would possess potential fertility, but could only become really fertile by methods of soil treatment which would bring about a conversion of the dormant plant food into available forms.

View of Permanent Rotation Plots, Werribee—Wheat, Oats, Bare Fallow Rotation.

It must be clear, also, that under certain circumstances the amount of available plant food in the soil may be reduced to such a low level that there is insufficient for the requirements of a normal crop. Such a soil is said to be " worn out," or "exhausted."

It was formerly supposed that the fertility of a soil could be determined by chemical analysis. Soils were analysed, and the analysis referred to arbitrary standards, and judgment was given on the agricultural possibilities of the soil under review. If, for example, a given soil were analysed and found to contain 0.1 per cent. of nitrogen, 0.1 per cent. of phosphoric acid, and 0.2 per cent. of potash, it was judged to be a good soil. But no agriculturist who knew his business would attempt to judge a soil merely by the results of its chemical analysis, and to say what crops should be grown and what manures should be applied.

Soil analysis can inform us regarding the total reserves of food in the soil, or it may inform us as to the amount of food soluble in dilute solution of citric acid, but it can throw very little light on the forms in which the mineral nutrients actually exist in the soil, and as to the amount actually available for a wheat crop.

A properly conducted soil survey, which would take into consideration the physical texture of the soil, its drainage and sub-soil features, as well as the chemical composition of the soil types, would be very helpful to the agriculturist, especially if the soil types were correlated with the known results of systematic field experiments.

Physical Condition of the Soil.—A soil exceedingly rich in total nitrogen, phosphoric acid and potash, and in available plant food, may be incapable of growing a blade of grass, much less a satisfactory crop. This may be the case with naturally rich but badly drained soils, and sour land, such as, e.g., one would expect in a swamp.

Hence, to be fertile, a soil must not only be rich in plant food, but it must possess a satisfactory physical condition. However rich a soil may be in plant food—total or available—its fertility will be low, if it is sour, or in need of draining, unretentive of moisture, or of poor texture, and low capillary power.

The physical condition of the soil is determined mainly by the size of its particles, i.e., its texture. The soil particles are classified according to their size into the following groups:—Fine gravel, coarse sand, medium sand, fine sand, very fine sand, silt, fine silt, and clay. The fractions fall into two groups—

(*a*) Sand and coarse part of the silt (above .01 m.m.). These particles are mainly silica.

(*b*) Clay and fine silt (below .01 m.m.), which are mainly complex silicates containing much iron and alumina.

The clay fraction is in contrast with the coarser fractions in chemical and physical properties.

Soils have the power of precipitating salts of ammonium, potassium, and phosphates, as well as organic compounds from their solutions.

Way and others have shown that the active constituent possessing this power was the clay. The properties of clay are of great importance to soil fertility. If present in excess, the free movement of water and air in the soil is impeded, and the soil becomes water-logged in wet weather. The soil is rendered so adhesive that the implements cause the formation of large clods unfavorable to plants. The injurious effects of excessive quantities of clay are greatly reduced by the application of lime, gypsum, or organic matter, which cause the fine particles to flocculate and assume a compound crumb structure.

When clay is present in moderate amounts it causes the soil particles to gather together and form a good tilth. As the particles of clay are exceedingly fine, they present a very high surface area per unit of weight, hence soils containing clay are very retentive of moisture.

Coarse sand, on the other hand, lacks cohesion, and makes a soil open and friable. It has a low water-holding capacity, and if present in excess the soil is unsuited for cultivation.

The presence of silt assists in maintaining the even conditions of moisture so desirable for the growth of crops. It is fine enough to retard, but not to prevent percolation, and is retentive of water, and permits free movement of water by capillarity.

Carbonate of lime has an important influence on the fertility of the soil. It dissolves in water containing carbon dioxide in solution, forming a soluble bicarbonate that flocculates clay and improves the texture of a clay soil.

The grey soils of the Wimmera owe their value mainly to the carbonate of lime they contain. The Wimmera grey soils (this *Journal*, March 1924, p. 134) contain nearly three times as much fine-grained particles as the Wimmera red soils. Notwithstanding this they are on the whole much more easily cultivated than the red soils. The grey soils are sticky when wet, but they break down easily into a powdery tilth when dry. The grey soils contain ten times the lime content of the red soils. This great difference in the lime content is mainly responsible for the difference in the tillable qualities of the two soils.

The organic matter is an important factor in determining the physical condition of the soil. It imparts a dark brown or black colour to the soil. It has an extraordinary capacity for retarding water, and its presence in the soil greatly increases the water holding capacity. It can withdraw ammonium, potash, and phosphoric acid from their solutions. It provides material for the production of nitrates, and furnishes the useful micro-organisms with a source of energy. Finally it markedly improves the tilth and mechanical condition of the soil. The fertility of many Victorian soils, e.g., Camperdown, Koroit, Koowee-rup, and Orbost, is largely due to the high percentage of organic matter they contain.

Biological Condition of Soil.—The soil used to be regarded as a mere inert mass of matter. We now know that it contains an immense number of microscopic bacteria, which play a most important part in the nutrition of plants. The importance of these lowly organisms may be appreciated by briefly referring to the functions of the more important bacteria found in every soil.

The most important group of organisms are the nitrifying bacteria. The nitrogen required by the wheat plant can only be taken in by the root in the form of nitrates. These nitrates are formed from the organic matter of soil by three distinct processes, each process involving a distinct set of bacteria. The process by which this organic nitrogen is converted into nitrates is called nitrification. These nitrifying organisms require for their full development—(*a*) air; (*b*) warmth —they thrive best at 99 degrees F., and are ten times more active at that temperature than at 57 degrees F.*; (*c*) moisture; (*d*) presence of lime; (*e*) organic matter.

Opposed to these nitrifying organisms are the denitrifying bacteria, which are most active when the soil is deficient in air, as a result of bad drainage or want of tillage. When these bacteria are active, the soluble nitrates quickly disappear, and even dissipate to free nitrogen, and crop yields are reduced. Every effort should be made, therefore, to reduce the activity of these organisms to a minimum.

Again, in well-tilled, well-drained soils, the organic matter of the soil becomes slowly oxidized by a group of putrefactive bacteria to carbon dioxide and other products. It is through the direct action of the several forms of bacteria, and through the indirect effects of the products of these organisms, that portion of the insoluble mineral plant foods of the soil is rendered available for the use of crops.

* Schloesing and Muntz.

In badly-drained soils, where the organic matter decomposes in the absence of air, marsh gas and organic acids are formed, and sourness and acidity in the soil thereby result.

On the roots of well-grown specimens of the *Leguminosæ*—the pea family of plants—colonies of bacteria of great economic importance exist. The curious nodules or wart-like growths on the roots of clover, peas, beans, and lucerne, are the dwelling-places of teeming millions of organisms. They live in a sort of partnership with the legume, and have the power of fixing free nitrogen from the air and making it available for the plant in return for a supply of carbonaceous food given by the plant. Thus, they enable a farmer to supply his soil with its most expensive plant food free of cost. This interaction is called symbiosis, and may be described as a kind of partnership in which two organisms, differing widely in character, live together for the advantage of both.

Organisms have been isolated by Winogradsky and Beyerinck which are able to fix the nitrogen of the air without associating themselves with any leguminous plant. These organisms secure the food necessary for their energy from the decaying organic matter of the soil.

Finally, recent research has revealed the presence of numerous organisms called *protozoa*, which prey on the various bacteria in the soil. It would appear that these organisms—the natural enemies of the bacteria—are destroyed by exposure to moderately high temperatures, leaving a free field for the development of the bacteria.

The tendency of this teeming bacterial population of the soil is to arrive at a state of equilibrium appropriate to the nature of the soil, and its physical condition. In well-tilled soils, in good "heart" and condition, containing adequate supplies of carbonate of lime and organic matter, the useful types of bacteria predominate. In badly-tilled soils, sour through want of drainage, or from an absence of lime, moulds, fungi, and harmful types of bacteria flourish to the exclusion of the useful forms.

Summing up, we may say that a soil, to be fertile, must be satisfactory from three points of view:—

(*a*) It must contain a sufficiency of plant food in a properly assimilable form.

(*b*) It must possess a suitable texture, i.e., a good balance of sand, silt, and clay particles, a good supply of organic matter, and be well drained, retentive of moisture, and of good capillary power.

(*c*) It must possess a suitable soil flora, and be in a condition favorable for the development of the bacteria that work for the benefit of plants.

MANURING.

The object of manuring is to supplement the supplies of plant food in the soil to such an extent as to enable a full crop to be grown.

The substances requiring special attention are those in which the soil is likely to be deficient, namely, nitrogen, phosphoric acid, and potash.

Occasionally, however, manures are applied with a view of improving the physical and biological condition of the soil rather than augmenting the supplies of plant food. This is the case when soil amendments, such as lime, gypsum, and green manures, are used.

If the soil is deficient in any one of the necessary ingredients, no amount of tillage can put it into good "heart"; and, as the yield of the crop is governed by the amount present of the most deficient soil

ingredient, it is imperative that the deficiency be made good by the direct application of fertilizers if satisfactory crops are to be obtained.

How to Determine Soil Deficiencies.

Soils vary considerably in their chemical composition, and it is important that every farmer should be able to determine for himself in what elements his soil is deficient. It has already been observed that chemical analysis is of little value for this purpose.

The most practical method of determining the soil requirements is establishment of a simple set of experimental plots.

A simple and effective scheme is to arrange for the sowing of a series of plots at seed time with the following treatment:—(*a*) No manure; (*b*) phosphates alone; (*c*) nitrates alone; (*d*) phosphates and nitrogen; (*e*) phosphates, nitrogen, and potash. If the growth and development of these be carefully observed and the yields from each separately determined the experimenter will be able to determine what class of manure is likely to prove profitable under his particular conditions. On badly-drained, sour soils, in regions of heavy rainfall, lime supplemented by phosphates should be included. Having determined which ingredient is deficient in his soil, the farmer may now proceed to determine in a similar manner the most profitable and economical form in which this ingredient may be applied, under his conditions, as well as the most profitable rate at which it may be applied.

These field tests have been conducted for the farmer in many districts by the Department of Agriculture. The results of the experiments may be applied to all soil and climatic regions similar to those on which the tests have been made.

Classification of Manures.

Manures may be divided into two general classes. Those supplying elements in which the soil is deficient are called Direct manures; whilst those which improve the physical and biological condition of the soil are spoken of as Indirect manures. Again, Direct manures may supply all the elements of plant food, in which case they may be called General manures; or they may contain one dominating plant food ingredient such as phosphorus, potash, or nitrogen, in which case they are named Special manures. Finally, the Indirect manures may be either vegetable in character, such as green manures, or mineral, such as lime, gypsum, salt.

The following tabulated statement may assist in making the matter clear:—

- Manures
  - Direct
    - Special
      1. Nitrogenous
      2. Phosphatic
      3. Potassic
    - General—Farmyard manure
  - Indirect
    - Mineral—Lime, gypsum
    - Vegetable—Green manures.

The wheat-grower is most interested in the Special manures.

Nitrogenous Manures.

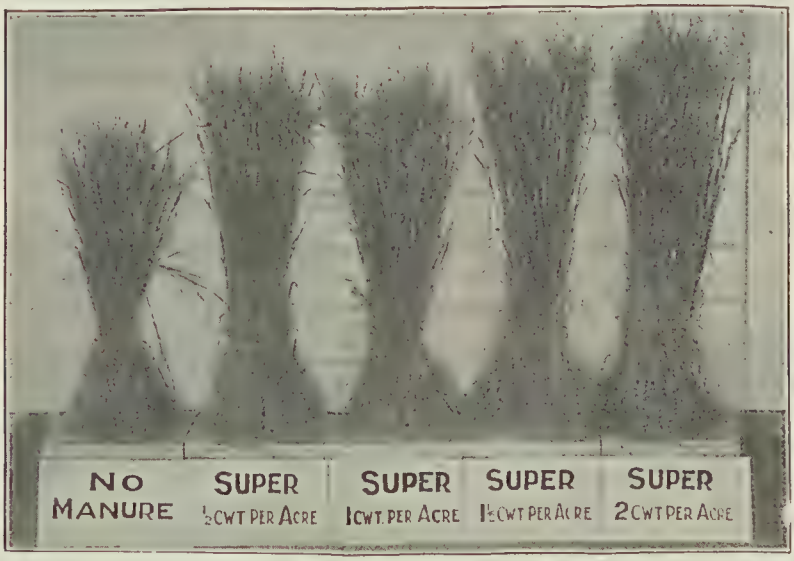
In European agriculture, a controlling factor for successful cropping is the amount of available nitrogen present in the soil. The limiting factor in crop production in Australia is the amount of available phosphoric acid present in the soil.

The importance of this distinction is obvious. The cereal farmer of the Old World must supply the all-important nitrogen, either through the medium of costly nitrogenous manures, or by providing a regular scheme of rotation in which leguminous crops play an important part.

The cereal farmer of Australia finds expensive and costly nitrogenous manures, like nitrate of soda and sulphate of ammonia, unnecessary, and he is thereby saved the great expense incidental to their application.

Why Nitrogenous Manures are Unnecessary.

Why, we may ask, are nitrogenous manures unnecessary and even unprofitable in the wheat areas of the state? At first sight, one might be inclined to the belief that our soils were richer in supplies of nitrogen than those of Europe. Examination of typical soils in the wheat areas, however, prove that such is not the case.



Representative Samples from Manurial Field—State Research Farm, Werribee, showing the effect of Superphosphate in hastening the Maturity of Cereal Crops.

Many instances might be quoted of Australian soils which have proved unresponsive to the application of nitrates, even though they would be regarded as lamentably deficient in total nitrogen if judged by European standards of fertility.

The soils of our wheat areas have not been under cultivation for such a length of time as to reduce the supply of available nitrogen below the yearly requirements of crops. Moreover, owing to our peculiar climatic and soil conditions, the percentage of nitrogen in an available form is considerably higher than under the wet conditions of Europe, where nitrates are so very necessary. Under European conditions, the heavy rainfall causes considerable losses of nitrates by leaching, and large quantities of nitrates are found in the drainage waters. In contrast to this, underground drainage is unnecessary in the wheat areas, and the losses of nitrates by leaching are negligible.

Again, our system of cropping is not as intensive as that of Europe. Owing to the fact that but one crop is grown in two, or even three, years

in the wheat areas, the demands made on the soil are not nearly so heavy as in European countries, where heavy crops are annually removed.

Finally, the conditions of soil and climate, and mode of cropping in our wheat areas, are conductive to rapid nitrification of the organic matter, resulting in the formation of a sufficiency of available nitrates for all demands of the cereal crop.

Most of the wheat sown in this state is on fallowed land, and during the progress of fallowing nitrification proceeds at a very rapid rate.

Results at Longerenong, 1924.

Some idea of the amount of nitrates produced in well tilled fallows may be gained from the results of investigations made at the Departmental field at Longerenong in May, 1924.

On 1st May, 1924, samples of soil were taken from the Longerenong College plots to a depth of 3 feet on (*a*) summer fallowed land (i.e., fifteen months' fallow), (*b*) winter fallowed land (nine months' fallow), and (*c*) on adjoining pasture land. The moisture content and the amount of nitrate nitrogen present in each plot were determined. The results are summarized in the table:—

TABLE SHOWING AMOUNT OF MOISTURE AND NITRATE NITROGEN IN UPPER 3 FEET OF SOIL ON (*a*) SUMMER FALLOW, (*b*) WINTER FALLOW, (*c*) PASTURE LAND, ON 1ST MAY, 1924, LONGERENONG.

Moisture Content.	Summer Fallow.	Winter Fallow.	Pasture Land.
	%	%	%
1st foot	26·27	20·50	12·73
2nd foot	26·45	23·59	17·58
3rd foot	25·24	22·34	18·00
Average for 3 feet	26·00	22·14	16·10
Nitrate Nitrogen (lbs. per acre) ..	101·5	112·75	Trace.

If we assume that the weight of an acre foot of soil averages 3,500,000 lb., the extra moisture conserved by the summer and winter fallow, respectively, over that of the adjoining pasture land was as follows:—

Summer fallow ... ... 4.57″
Winter fallow ... ... 2.66″

There was present in the fallows from 100 to 112 lb. of nitrate nitrogen, equivalent to 675 to 740 lb. of nitrate of soda, as compared with mere traces of nitrate in the pasture land.

We see at a glance from these figures the reason why, in the northern areas, under the existing methods of cultivation, the application of nitrogenous manures are unnecessary and unprofitable.

In the southern and western districts of Victoria, however, the same climatic and soil advantages as regards nitrate production do not hold, for in these districts fallowing is far less common and the rainfall is heavier, and it might be inferred that nitrogenous manures would prove of some value there.

The needs of the north and south in this respect have been made the subjects of separate inquiry by this Department.

The experiments conducted brought out their differences as resulting from climate. Thus, in the northern wheat areas the addition of soluble nitrogenous manures (sulphate of ammonia) to phosphate gave an increase of only 3 lbs. of wheat per acre, on the average of 94 farms, and in no single case of the twelve local groups into which the 94 farms were divided did the nitrogenous manure repay the cost of its purchase. In many cases it did actual harm—probably as a result of increased leafage causing too rapid a drain on the soil moisture.

In the moister southern districts the need for some nitrogenous manure was apparent in the experiments, for an increase was obtained in 47 of the 50 farms by its use.

On the average of the 50 farms, 1 cwt. of nitrate of soda increased the yield of hay by nearly 6 cwt., and 1 cwt. of sulphate of ammonia by exactly 8 cwt. per acre.

It may be said, therefore, that the need for nitrogenous manures in this state is to some extent dependent on the length of time the land has been under cultivation and upon the climate. In the drier portions of the state the use of nitrogenous manures does not seem to be called for, and it may even prove harmful. In the wetter districts a limited call for nitrogenous manures exists at the present time, and this may be expected to develop as cultivation becomes of older date.

Manures Containing Nitrogen.

The principal nitrogenous manures are nitrate of soda, sulphate of ammonia, blood manure, calcium cyanamide, and nitrate of lime.

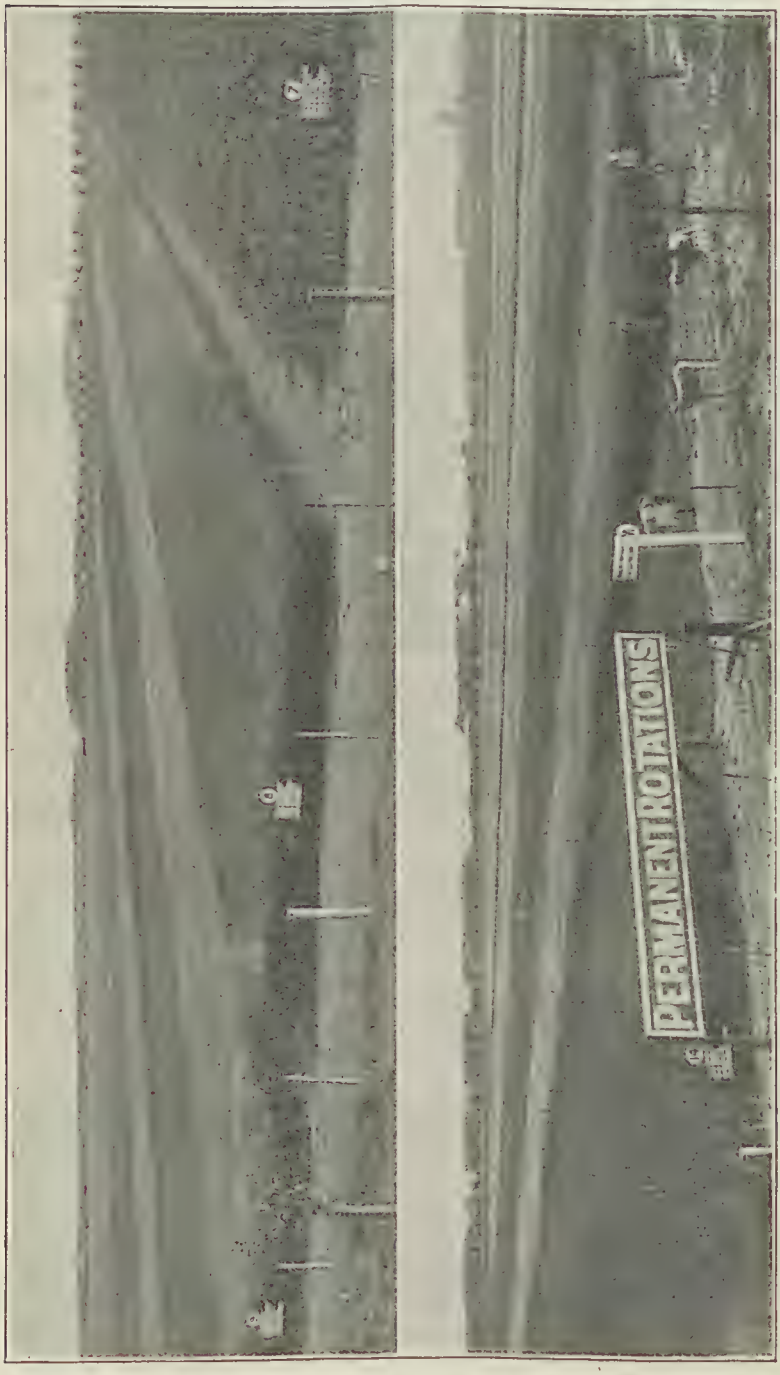
Nitrate of Soda is obtained principally from the nitre beds of Chili and Peru, and Bolivia. The commercial article contains about 15½ per cent. of nitrogen.

It is extremely soluble in water, and is very readily leached out of the soil by excessive rains. For these reasons it is generally applied as a top dressing, more especially in districts with a heavy rainfall. In order to ensure its uniform distribution, it should be mixed with two or three times its weight of dry loam, and broadcasted over the crop. According to Lawes and Gilbert, nitrate of soda applied in early winter is never as effective as when applied in spring.

Nitrate of soda gives the best results when the soil is well supplied with phosphates and potash, and is deficient in available nitrogen. If it is to be used in conjunction with superphosphate, it is inadvisable to mix the manures together long before sowing, as a loss of nitric acid may result. The most profitable rate of application for any particular soil and crop should be determined by experiment. Rainfall and soil type are the most important determining factors. Generally speaking, however, from ½ to 1 cwt. per acre is used for hay crops where nitrates have been proved to be necessary.

Sulphate of Ammonia is a by-product in the destructive distillation of coal, and is obtained from the "gas liquor" of gasworks by neutralizing it with sulphuric acid. The commercial article is a greyish-white crystalline salt, extremely soluble in water.

It contains about 20 to 21 per cent. of nitrogen, and is the most concentrated and expensive of nitrogenous manures. If pure, it should entirely volatilize when placed on a red hot spoon. Lawes and Gilbert have used it with great success in the cultivation of wheat at Rothamsted, and have demonstrated that for every 5 lbs. of ammonia added to the soil an extra bushel of wheat was produced. It is similar in its action to nitrate of soda, but before being used it must first undergo nitrification.



View of Permanent Rotation Plots—State Research Farm, Werribee.

Above—Rotations including hay crops. Below—Rotations including grain crops.

It is more readily held by the soil than nitrate of soda, and is therefore preferable to nitrate of soda in wet seasons and on soils of a light loamy character. The continued application of sulphate of ammonia to soils deficient in lime leads to the removal of some of the lime in the form of gypsum, and the soil becomes acid and unsuitable for the growth of crops.

It may be mixed with superphosphates, but not with basic slag, or manures containing free lime, as portion of the ammonia may be lost. It may be applied, like nitrate of soda, as a top dressing, but should be used rather earlier in the season than nitrate.

Dried Blood is a highly nitrogenous organic manure, containing about 10 to 12 per cent. of nitrogen. It is not so rapid in its action as nitrate of soda, as it must first undergo a preliminary nitrification before it becomes available. It is of considerable value in light loamy soils, and is an excellent manure for market-gardening purposes.

Calcium Cyanamide and Nitrate of Lime.—In 1898 Sir William Crookes suggested that, by the utilization of water-power, electrical

Discing Land for Summer Fallowing.

energy might be generated at such a cheap rate as to make the fixation of the nitrogen of the air by electrical means a financial success.

His suggestion was adopted, and at Nottoden the Norwegian Nitrogen Company is now manufacturing nitrate of lime electrically from the nitrogen of the air.

The fertilizing powers of nitrate of lime and nitrate of soda for equal amounts of nitrogen are approximately the same. Experiments have recently shown that on sandy soils deficient in lime, nitrate of lime has a more beneficial effect than nitrate of soda.

Calcium Cyanamide or Nitro-lime is prepared from the nitrogen of the air by causing it to combine with calcium carbide at the high temperature of the electric furnace.

Consideration has already been given to the factors involved in soil fertility, and to the position of nitrogen in Victorian agriculture. The wheat areas of Victoria differ very widely from those of Europe in regard to available nitrogen supplies, owing mainly to the exceptional rate at which nitrification proceeds under the conditions which obtain in our wheat areas. It is now necessary to consider the requirements of the wheat areas with respect to phosphoric acid and potash.

Phosphatic Manures.

Importance.—Phosphatic manures are of the greatest practical importance to the cereal farmer. One striking peculiarity in Australian soils, as compared with those of Europe, is the uniformly low phosphatic content.

We need not here enter into a speculative discussion as to the probable causes of this deficiency. It is sufficient to note that practical experience and experimental work throughout the wheat belt of Australia has conclusively demonstrated the value and necessity of phosphates in cereal culture. In many of the wheat areas the use of soluble phosphates is absolutely essential to secure a crop. The importance of soluble phosphates in Victoria is strikingly demonstrated by the following table:—

TABLE SHOWING THE DEVELOPMENT OF THE USE OF ARTIFICIAL MANURES (MAINLY SUPERPHOSPHATE) IN VICTORIA.

Season.	Farmers Using Artificial Manures.	Area Manured.	Manure Used.	Area Under Wheat.
		acres.	tons.	acres.
1901–2	11,439	556,777	23,535	1,754,417
1911–12	26,159	2,676,408	82,581	2,164,066
1921–22	40,037	4,148,780	172,897	2,611,198

1.—*Effect of Phosphates on Growth of Wheat.*

An application of phosphate removes one limiting factor to production. The limiting soil factors in the growth of wheat in Victoria are soil moisture and soluble phosphate. The former factor can to some extent be removed by bare fallowing, which normally conserves from 3 inches to 5 inches of moisture. The latter factor may be removed by an application of superphosphate with the seed.

The size of the crop is determined by the amount present of the most deficient soil ingredient.

A cask composed of staves of different lengths has a certain capacity for holding water. If we lengthen the shortest stave, the capacity of the cask is increased, and the second shortest stave now becomes the measure of the capacity of the cask. The capacity of the soil for wheat production is determined by the amount of soluble phosphate present. If we add a liberal dressing of phosphate, the cropping capacity of the soil is greatly increased, and some other constituent now becomes the determining factor in production.

Phosphates increase wheat yields. Evidence of this will be submitted later.

2.—*Phosphates Promote Root Development.*

Lawes showed that the application of superphosphate led to the development of the lateral and fibrous roots of the plants. Watt showed that the application of soluble phosphates to a wheat crop encouraged deep-rooting habits.

Phosphates are particularly valuable wherever greater root development is required than the soil conditions normally bring about. They are, therefore, of special value on clay soils, where roots do not naturally form well, and for shallow-rooted crops with a short period of growth, *e.g.*, barley.

As the application of soluble phosphates encourages deep-root development, they are beneficial wherever drought conditions are likely to prevail. Hall has suggested that the marked effect of superphosphate on wheat in the dry regions of Australia may be due to the fact that phosphates induce the young roots to grow rapidly into the moister layers of soil beneath the surface.

3.—*Phosphates Required for Early Development of the Plant.*

The movements of phosphoric acid from one part of the plant to another are remarkable. Phosphoric acid is the most mobile of the inorganic constituents of the plant. Arendt found phosphoric acid in the oat plant continually passing from the lower to the upper parts, especially after flowering.

The upper leaves and stem gave up more than 80 per cent. of the phosphoric acid they had accumulated and sent it into the ears.

Voelcker points out that the seeds of plants contain much phosphoric acid, whilst the soil usually contains very little. By putting phosphates in reach of the young plant, we simply act upon a hint which has been "given by Nature in the care she takes to provide young plants in their earliest periods of existence with a constituent which possesses such a remarkable effect in pushing the young plant."

There is present in the protoplasm of the vegetable cell, and especially in the nucleus, an albuminoid substance called nuclein, which contains several per cent. of phosphorus, taken either from the phosphates in the original seed or from the phosphates in the soil. Phosphates are required for cell-division, and therefore for the vigorous growth of the plant. Thus, Lawes found that fat and albumen accumulated in the absence of phosphates, but that as soon as a trace of potassium phosphate was added, energetic cell-division took place.

Phosphates are also required for the transformation of the starch, formed as a result of photosynthesis, into sugars. Thus, Reed showed that starch was formed in the absence of phosphorus, but that it did not change to sugars.

We are therefore justified in assuming that, as Nature is so very careful in furnishing the embryo with an abundance of phosphates stored up in the seed, and since phosphates are so essential for energetic cell-division and for the transformation of starch into sugar, the presence of soluble phosphates in the soil during the early stages of the young crop is essential to vigorous growth and active development of the crop in its early stages.

4.—*Phosphates Hasten the Maturity of the Crop.*

Phosphates promote the early maturity of the crop. This may be seen in a striking manner on the permanent fertilizer plots at the State farms. The plots liberally dressed with soluble phosphates turn colour from ten to twelve days before the unmanured plots. In dry seasons this earliness of maturity is of decided advantage to the crop.

5.—*Phosphates Economize Water Supply of the Soil.*

One important effect of soluble phosphates is to materially lower the transpiration ratio. This has been demonstrated by the writer, who showed that with wheat the transpiration ratio on unmanured controls was 377 for dry matter and 1,355 for grain. Where a normal dressing of nitrogen, phosphoric acid, and potash was applied the transpiration ratios were reduced to 292 for dry matter and 1,216 for grain. With excess dressings of the same plant nutrients the transpiration ratios

were reduced to 270 and 871 for dry matter and grain respectively. In other words, the unmanured controls gave a 29 per cent. higher water requirement than the normal dressing and 39.6 per cent. higher water requirement than the heavy dressing.*

Fertilizers applied to soils either naturally poor or deficient in any nutrient not only greatly stimulated the yield, but appreciably lowered the water requirement both for dry matter and grain.

The addition of liberal dressings of soluble phosphates to a crop already well supplied with available nitrogen (as in well-worked fallows) not only increases the vigour and size of the crop, but lowers the transpiration ratio and brings about a more effective use of the limited supplies of soil moisture.

The actual amount of water used by a manured crop is greater than that of the unmanured crop, for transpiration is dependent mainly on the leaf surface area exposed; but in the case of the manured crop, the plants build up dry matter economically throughout the whole time they are transpiring water; whereas with the unmanured crop, transpiration proceeds continuously although the crop may be gaining but little in weight. These are matters of vital importance in a region of limited rainfall.

Sources of Phosphates.

The principal source of phosphoric acid is the mineral phosphates. The phosphoric acid is present in these in the form of tricalcic phosphate. These phosphates are widely distributed, and the principal deposits are found in the United States, Pacific Islands, Tunis, Algeria, France, and Belgium. Phosphatic deposits have also been found in South Australia and at Mansfield, in Victoria, but these have not been used to any considerable extent, mainly owing to their comparativey low phosphate content as compared with Nauru phosphate—the source from which Australian supplies are now obtained.

Other sources of phosphoric acid are bones, phosphatic guano, and the basic slag produced from iron ores rich in phosphorus.

Forms of Phosphate.

Three chemically different forms of phosphate of lime are met with. Phosphoric acid may be regarded as $3H_2O.P_2O_5$. Phosphoric acid forms with lime three distinct compounds. According as one, two, or three parts of water in the acid are replaced by lime, we get mono-, di-, and tricalcic phosphate. A knowledge of the composition solubility of these phosphates, and the manures in which they are found, is of practical importance to the farmer.

The degree of solubility of these forms varies. Thus, the tricalcic form is insoluble in water and weak organic acids. It is soluble only in mineral acids, e.g., sulphuric acid. This is the form in which phosphorus is found in bones, rock phosphate, and guano. It corresponds with the insoluble phosphate recorded on the manure labels.

The dicalcic form is insoluble in water but soluble in weak organic acids and in citrate of ammonia. It is the form in which phosphate is found in reverted superphosphate, and is the principal form present in so-called basic superphosphate. It corresponds with the "citrate soluble phosphate" on the manure tags.

Monocalcic phosphate is the most important of these phosphates for the cereal-grower.

* Water Requirements of Farm Crops.—A. E. V. Richardson, Bulletin, Department of Agriculture, Victoria.

This phosphate is freely soluble in water, and is of immediate value as plant food. It is the form in which phosphoric acid is found in superphosphate and dissolved bones. It corresponds with the " water soluble phosphate " in the manure guarantees.

The following table summarizes these facts:—

TABLE SHOWING COMPOSITION AND SOLUBILITY OF VARIOUS PHOSPHATES OF LIME.

Name.	Composition.	Formula.	Solubility.	Found in—
1. Triclacic phosphate (insoluble phosphate)	Lime, Lime, Lime } Phosphoric acid	$3CaO, P_2O_5$ or $Ca_3(PO_4)_2$	Insoluble in water and citrate of ammonia	Bones, guano, mineral phosphate
2. Dicalcic phosphate (" Reverted phosphate," " slowly soluble phosphate ")	Lime, Lime, Water } Phosphoric acid	$2CaO, H_2O, P_2O_5$ or $Ca_2H_2P_2O_8$	Insoluble in water; soluble in citrate of ammonia	Reverted super.
3. Monocalcic phosphate (water soluble phosphate)	Lime, Water, Water } Phosphoric acid	$CaO, 2H_2O, P_2O_5$ or $CaH_4P_2O_8$	Soluble in water ..	Superphosphate, dissolved bones

In addition to these phosphates there is a form found in basic slag. Morison* states that it is a complex silico phosphate, and that its composition is probably 5 (CaO). FeO. S_1O_2 P_2O_5.. It is, however, soluble in citric acid, and in Europe it is highly valued as a fertilizer, especially for grass lands.

SUPERPHOSPHATE.

This is the fertilizer most extensively used by wheat-growers. There are very few soils in the wheat areas that will not give a profitable response to applications of superphosphate, and in dry seasons many soils fail to produce a crop without water soluble phosphate.

Liebig, in 1840, suggested that insoluble tricalcic phosphate—the form in which phosphoric acid exists in bones and mineral phosphates—could be changed into water-soluble monocalcic phosphate by treatment with sulphuric acid. The product obtained as a result of this action is superphosphate. When sulphuric acid acts in the tricalcic phosphate, two parts of lime are abstracted from the latter compound, and two parts of water are substituted. A mixture of monocalcic phosphate and gypsum is, therefore, formed, which constitutes the superphosphate of commerce. The reaction may be represented thus:—

$$\underset{\text{(Tricalcic phosphate)}}{3CaO.P_2O_5} + \underset{\text{(Sulphuric acid)}}{2(H_2O.SO_3)} = \underbrace{\underset{\text{(Monocalcic phosphate)}}{CaO.2H_2O.P_2O_5}}_{\text{Superphosphate.}} + \underset{\text{(Gypsum)}}{2(CaO,SO_3)}$$

Thus superphosphate consists of a mixture of monocalcic phosphate and gypsum.

Reversion of Superphosphate.

The rapidity of the action of superphosphate is due to the solubility of the phosphate portion in water. It thus supplies phosphoric acid in a form that can be immediately used by the young crop. It is known,

* Journal of Ag. Science (1909).

however, that the soluble phosphate in superphosphate undergoes gradual reversion, i.e., change to less soluble forms, when the fertiliser is applied to the soil.

The carbonate of lime, alumina, and iron compounds in the soil are largely responsible for bringing about this change from a water-soluble phosphate either to citrate soluble or to insoluble phosphate. This being so, one naturally asks wherein lies the superiority of superphosphate, and why should the manufacturer go to the expense of converting the insoluble rock phosphate into a water-soluble phosphate if the soluble phosphate begins to revert when it is applied to the soil. The probable explanation is that the phosphate in superphosphate, immediately it is applied to moist soil, becomes dissolved in the soil water, and assumes a condition infinitely more minute than could ever be obtained by any process of mechanical grinding. In this extremely fine state of subdivision it diffuses through the surface layers of soil, and gradually becomes reverted on the colloidal or other fine particles of soil. This extreme state of subdivision of the particles of phosphate, combined with its intimate diffusion through the soil, makes it superior in its action to citrate soluble or citrate insoluble phosphate. Wherever the minute root hairs go in search of phosphate in a soil liberally dressed with superphosphate, small quantities of very finely-divided phosphate in a more or less assimilable form are to be found coating the finer soil particles.

Superphosphate has demonstrated its superiority over other fertilizers throughout the entire wheat belt of Victoria, and also on pasture lands throughout an area of country extending from Portland to Bairnsdale, and from Tallangatta to Goroke.

The Soil Fixes Phosphate Solutions.

The process of fixation of phosphate is of practical importance. Carbonate of lime, compounds of iron, and alumina are able to arrest any water-soluble phosphate that may be in the soil. Colloidal clay and organic matter also have this power.

Voelcker filtered barnyard liquor through loamy soils, and found that practically all the soluble phosphate in the liquid was speedily fixed by the soil. Dyer was able to show by analyses of soil from plots heavily manured with phosphates, and from unmanured plots at Rothamsted, that the phosphate added over a period of 70 years did not penetrate the subsoil. He found that the difference between the phosphate content of the soil of the two sets of plots was approximately equal to the total quantity of phosphoric acid which had been applied to the fertilized plot during the 70 years, minus the difference in the calculated quantity removed by the overhead portion of the crops from the two plots.

This power of soil to fix water-soluble phosphate is of practical importance. Farmers often raise the question as to whether the phosphoric acid will not be washed out of the superphosphate if it is applied in autumn to grass land. It may be said that on most normal soils, i.e., soils containing moderate amounts of clay, carbonate of lime, or organic matter, there is no danger of losses of phosphate by leaching.

Rate of Application of Superphosphate.

The rate at which superphosphate should be applied depends on (1) the rainfall, (2) the nature of the soil, (3) the nature of the crop.

The higher the rainfall, the greater the amount of superphosphate that can be profitably applied. Light dressings are the rule in the semi-arid portions, e.g., north-western Mallee, while heavy dressings are used in the more favoured Western District.

The soil is obviously an important factor, its natural richness in phosphoric acid and its lime content being determining factors. On soils rich in carbonate of lime heavy dressings may be regularly used. Thus, on certain limestone soils of South Australia dressings of 2 cwt. superphosphate are common. Probably reversion is more rapid and complete on these soils than on those of low lime content. Again, the phosphate content of the soil is important. On the rich alluvial flats at Orbost, and on the rich volcanic soils of the Western District, phosphates give but little response. On the other hand, the application of soluble phosphates to Mallee lands gives an immediate and substantial increase in yield.

Finally, the nature of the crop is important. Potatoes and lucerne respond to heavy dressings of phosphate, even on comparatively rich soils. Applications of from 4 to 6 cwt. per acre are frequently applied to potatoes. On the other hand, the limit of increase with wheat is usually reached with an application of from 1½ cwt. to 2 cwt. per acre.

There is another factor to consider—the thoroughness of cultivation. The more thoroughly the soil is cultivated, the greater the quantity of manure that can be used. With slovenly methods of farming, heavy applications do not result in material increases in yield over lighter applications. This is accounted for by the fact that thorough tillage methods result in the conservation of much soil moisture, and this extra conserved moisture has the same effect as if the land was located in a region of heavier rainfall.

On well-tilled soils, from 60 to 90 lb. can be recommended for the Mallee areas, from 1 to 1¼ cwt. in the Goulburn Valley, from 1 to 1½ cwt. for the Wimmera, and from 1¼ to 1½ cwt. for the Western District. The average rates of superphosphate applied in these districts are much below these figures, but as tillage methods improve wheat-growers will find that the quantities that can be profitably used will steadily increase.

Heavy v. *Light Applications of Superphosphate.*

Twelve years ago the average dressing of superphosphate applied to wheat in the various districts was as follows:—Mallee areas, 30-40 lb.; Wimmera and northern areas, 50-60 lb.; Western District, 75 to 80 lb. per acre.

Experiments conducted by the Department of Agriculture at the State farms show conclusively that heavier dressings than are now generally applied would greatly increase production. Not only is the net profit greater with the heavier applications, but the indirect effect of the manure in stimulating the growth of grass following the wheat crop is much greater in the case of the heavy applications. In other words, heavy dressings give the maximum yield of wheat the season and soil will allow, and greatly stimulate the growth of grass when the land is left out of cultivation the following year.

Increased stock-carrying capacity is an important consideration to the wheat-grower, especially in view of the relatively high prices now (1924) current for wool and sheep.

Time and Mode of Application.

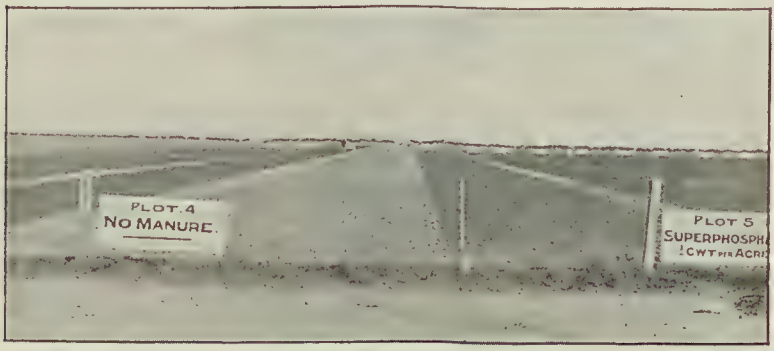
In the majority of seasons the best results are obtained with superphosphate when the seed and manure are drilled in together in the normal seeding season.

The advantage of sowing seed and manure together is that the young plants very readily find the manure, and make vigorous growth early in the season. They thus become well established, and develop a good root system before the winter sets in—a point of great importance in relatively dry districts. If the autumn has been unfavorable to the destruction of weeds, the sowing of seed and manure gives the young crop a decided start, and materially assists it in overcoming the weeds.

BASIC SLAG.

This is obtained as a by-product in the manufacture of steel from iron ores rich in phosphorus. It is sold as a fine, heavy, black powder. It is a very popular manure in Europe, both for wheat crops and for the improvement of pastures. It contains from 15 to 18 per cent. of phosphoric acid, and about 40 per cent. of lime.

It is not likely to displace superphosphate in the wheat areas, but on sour peaty land it will be found a most useful and valuable manure. Basic slag, however, by reason of the lime it contains, tends to correct the acid conditions, and thus acts as a soil amendment as well as a phosphatic manure. Basic slag is extremely valuable in the top-dressing of impoverished pastures.



Effect of Phosphate on Early Growth of Wheat—State Research Farm, Werribee.

Basic slag has given remarkable results in clay grass-lands of Europe, its action being to encourage the growth of white clover in the pasture, which increases the nitrogenous organic matter of the soil to such an extent that greater growth of grass becomes possible. These fertilizers are most effective on heavy clays and sour soils deficient in lime.

BONEDUST.

Bone consists of an organic and an inorganic portion. The organic portion comprises about 40 per cent. of the raw bone, and consists of (*a*) ossein or bone cartilage, which is very rich in nitrogen; and (*b*) fat. The inorganic portion, comprising about 60 per cent. of the raw bone, consists principally of tricalcic phosphate (phosphate of lime).

Hence, the fertilizing principal constituents of raw bones are organic nitrogen and phosphate of lime.

The presence of fat is, however, highly objectionable, for, in addition to being useless as plant food, it prevents the bones from being finely ground, and also protects the fertilizing ingredients from being made available. Hence, in the preparation of bonedust the fat is first removed from the bones by steaming or by treatment with benzine, and the treated bone ground to fine meal.

The value of a bonedust will depend on its composition and its fineness of subdivision. The purchaser should always insist on a guaranteed analysis for bonedust, for there is no fertilizer on the market so liable to vary in composition as the so-called bone fertilizers.

The phosphoric acid in bonedust is in a most insoluble condition. It is only very slowly made available in the soil, and therefore it has a very limited use in most of the wheat areas. It gives best results on soils rich in organic matter, for with these there is a possibility of the insoluble phosphate being slowly made available. On limestone soils in the drier districts, however, it has been proved of little value, because it takes so long for the tricalcic phosphate to be rendered available.

Other sources of phosphoric acid are the phosphatic guanos and raw ground phosphate rock. In both these substances the phosphoric acid is insoluble, and experimental work has demonstrated that they are of less value in the majority of our wheat areas than the soluble phosphate manures.

Many of the so-called "bone fertilizers" on the market consist of a mixture of bones with ground rock phosphate.

Ground Rock Phosphate.

Ground rock phosphate applied in the form of a fine powder has been used in parts of the United States. Beneficial results have been obtained on sour land and on peaty soils, especially when the material was very finely ground. For the wheat belt the phosphate shortage should be made good by the application of superphosphate.

Potash Manures.

Potassic manures do not figure very largely in Australian manurial practice. Most of the strong soils characteristic of the wheat areas are well supplied with potash, and further supplies in the form of artificial manures are generally unnecessary. There are some soils, however, on which potash may possibly be of considerable benefit. These are the light, sandy loams, and heavy, peaty soils. Dressings of potash are frequently necessary to secure a full crop from these soils, more especially with root crops, such as potatoes, onions, beets, &c. On the clay loams and stiff clay soils of the wheat areas, the application of potassic manures is generally unnecessary and unprofitable.

The principal potassic manures are sulphate and muriate of potash and kainite. These are obtained from the Stassfurt potash mines which form the principal source of the world's potash.

Sulphate of potash contains from 50 to 52 per cent. of potash.

Muriate of potash contains an equivalent of 60-62 per cent. of potash.

Kainite is one of the crude potash minerals of the Stassfurt mines. Its composition varies considerably, but it generally contains from 12-13 per cent. of potash, most of which is in the form of sulphate, whilst a lesser quantity is present as chloride.

Potash is required in fairly large quantities by leguminous plants, such as clover and lucerne, but the drain on the soil reserves of potash by wheat crops is very small indeed. It does not appear to be necessary for wheat crops in Victoria.

Notes on the Use of Artificial Manures.

Always Buy on Guarantee Analyses.

In purchasing artificial manures farmers should always study closely the guaranteed analyses of each manure. In the January number of

the *Journal of Agriculture* each year the Chemist for Agriculture publishes a statement of all manures registered under the Artificial Manures Act, together with their guaranteed percentages of the fertilizing ingredients present, and the unit values of nitrogen, phosphoric acid, and potash. These tables should be closely scrutinized by each farmer. The unit values will enable him to calculate the commercial value of any artificial manure selling on the market.

Mixing of Manures.

Care needs to be exercised in the mixing of manures. Fertilizers cannot be mixed indiscriminately without risk of loss, or of lowering the value of some of the plant food constituents.

With regard to nitrogenous manures, sulphate of ammonia, nitrogenous guanos, animal and blood manures should not be mixed with substances of a strongly alkaline character.

Quicklime, slaked lime, wood ashes, Thomas's phosphate, or basic slag should under no circumstances be mixed with these manures, since considerable loss of ammonia will result.

With regard to nitrate nitrogen, loss is liable to occur with nitrate of soda if much free sulphuric acid is present in superphosphates; especially if the manures are mixed some time before application, and are kept in a warm place. Provided, however, the superphosphate is well made and dry, and the mixing is performed at the time of sowing, little loss will occur.

In purchasing mixed manures attention should be paid to the guaranteed analyses.

The farmer should study particularly the guarantee for nitrogen, and see whether it is in the form of nitrate, ammonia, blood, &c., also the percentage of water-soluble, citrate-soluble, and insoluble phosphate should receive close attention. Frequently the prices asked for certain mixed manures are out of all proportion to their real commercial value, and in such cases the mixing can be most profitably done by purchasing fertilizers separately, and mixing them on the farm. A study of the unit values published each year in the *Journal* will enable each purchaser to determine for himself whether the prices asked for a given mixed manure are reasonable.

Manuring not a Substitute for Tillage.

It must not be assumed that the application of artificial manures will relieve the farmer of the responsibility of thorough cultivation.

There are some who appear to think that heavily manured crops do not require the same amount of tillage as unfertilized crops. As a matter of fact, heavy dressings of manure cannot be used at a full profit without thorough preparatory tillage. Thorough tillage always was, and always will be, a prime factor for the production of heavy crops. Jethro Tull doubtless placed an exaggerated value on tillage operations when he stated, more than a century ago, that manures were unnecessary if tillage operations were thoroughly performed, and that thorough tillage was the best substitute for manure. We, in the twentieth century, should remember that while fertilizers are essential on many soils for the production of profitable crops, they do not give their full measure of benefit unless the soil receives a thorough preparatory cultivation.

(*To be continued.*)

RESULTS OF POTATO MANURING TRIALS, 1923-24.

By J. T. Ramsay, Potato Expert.

Following the usual programme of this Department, manure trials on potato crops were conducted during the past season at five different centres in the principal potato-growing districts in the State. These were—Catani (Koo-wee-rup Swamp), Korumburra (Gippsland), Thorpdale (Gippsland), Trentham (Central), and Millbrook (Central). The results obtained at the first four stations are reported herein. Millbrook figures will be available by next month.

Manuring.

A uniform system of manuring was adopted at the four places reported here, namely:—

Dressing	No. 1	... 3 cwt. super. per acre.
,,	No. 2	... 6 cwt. super. per acre
,,	No. 3	... 9 cwt. super. per acre
,,	No. 4	... 6 cwt. super., 1 cwt. sulphate of potash per acre
,,	No. 5	... No manure
,,	No. 6	... 6 cwt. super., 1 cwt. sulphate of ammonia per acre
,,	No. 7	... 6 cwt. super., 1 cwt. sulp. amm. and 1 cwt. sulp. potash per acre
,,	No. 8	... 3 cwt. market garden
,,	No. 9	... 3 cwt. basic superphosphate.

In addition, one half of each area was treated with ground limestone at the rate of 1 ton per acre, the other half being left without lime.

Seasonal Conditions.

The season was one of the wettest on record, with low temperatures. This proved beneficial in regard to the growth of much higher than average tonnages of potatoes, but was also conducive to the development of certain fungus and bacterial diseases, which have effected a good deal of damage to crops generally. Little in the way of preventive work could be done during the past season on account of the almost continuous presence of moisture from the abnormal rains.

This condition also hampered intercultivation of crops to such an extent that it was a matter of considerable difficulty to keep fields in a fair state of tilth and freedom from weeds.

This, however, did not hamper appreciably the object of the experiments or demonstrations, which was, of course, to test the values of certain manures, by varying rates per acre, with and without the aid of lime, in influencing the yield of the potato crop. The results submitted are considered to be highly satisfactory, proving, as they do, the advisability of augmenting the natural fertility of soils by the judicious application of artificial fertilizers.

CATANI (KOO-WEE-RUP SWAMP).

Limed 1 ton per acre.

—	Yield.			Increase per acre due to Manure.		
	Tons	cwt.	qrs.	Tons	cwt.	qrs.
No. 1.—3 cwt. super. per acre	7	2	2	2	10	0
No. 2.—6 cwt. super. per acre	7	17	2	3	5	0
No. 3.—9 cwt. super. per acre	9	7	2	4	15	0
No. 4.—6 cwt. super., 1 cwt. sulphate of potash per acre	9	7	2	4	15	0
No. 5.—No manure	4	12	2		..	
No. 6.—6 cwt. super., 1 cwt. sulphate of ammonia per acre	11	12	0	6	19	2
No. 7.—6 cwt. super., 1 cwt. sulp. amm. and 1 cwt. sulp. potash per acre	12	5	0	7	12	2
No. 8.—3 cwt. market garden	*5	12	0	0	19	2
No. 9.—3 cwt. basic superphosphate	*7	2	2	2	10	0

* These two plots were badly affected with water.

CATANI (KOO-WEE-RUP SWAMP).

Unlimed.

—	Yield.			Increase per acre due to Manure.		
	Tons	cwt.	qrs.	Tons	cwt.	qrs.
No. 1.—3 cwt. super. per acre	7	19	2	3	12	0
No. 2.—6 cwt. super. per acre	8	5	0	3	17	2
No. 3.—9 cwt. super. per acre	9	0	0	4	12	2
No. 4.—6 cwt. super., 1 cwt. sulphate of potash per acre	8	12	2	4	5	0
No. 5.—No manure	4	7	2		..	
No. 6.—6 cwt. super., 1 cwt. sulphate of ammonia per acre	10	10	0	6	2	2
No. 7.—6 cwt. super., 1 cwt. sulp. amm. and 1 cwt. sulp. potash per acre	12	2	0	7	14	2
No. 8.—3 cwt. market garden	*5	12	2	1	5	0
No. 9.—3 cwt. basic superphosphate	*7	2	2	2	15	0

* These two plots were badly affected with water.

KORUMBURRA.

Limed 1 ton per acre.

—	Yield.			Increase per acre due to Manure.		
	Tons	cwt.	qrs.	Tons	cwt.	qrs.
No. 1.—3 cwt. super. per acre	13	19	2	7	4	2
No. 2.—6 cwt. super. per acre	14	2	2	7	7	2
No. 3.—9 cwt. super. per acre	13	7	2	6	12	2
No. 4.—6 cwt. super., 1 cwt. sulphate of potash per acre	15	7	2	8	12	2
No. 5.—No manure	6	15	0		..	
No. 6.—6 cwt. super., 1 cwt. sulphate of ammonia per acre	15	7	2	8	12	2
No. 7.—6 cwt. super., 1 cwt. sulp. amm. and 1 cwt. sulp. potash per acre	14	12	2	7	17	2
No. 8.—3 cwt. market garden	9	5	0	2	10	0
No. 9.—3 cwt. basic superphosphate	9	5	0	2	10	0

KORUMBURRA.

Unlimed.

—	Yield.			Increase per acre due to Manure.		
	Tons	cwt.	qrs.	Tons	cwt.	qrs.
No. 1.—3 cwt. super. per acre	11	5	0	4	10	0
No. 2.—6 cwt. super. per acre	12	10	0	5	15	0
No. 3.—9 cwt. super. per acre	12	0	0	5	5	0
No. 4.—6 cwt. super., 1 cwt. sulphate of potash per acre	11	7	2	4	12	2
No. 5.—No manure	6	15	0	..		
No. 6.—6 cwt. super., 1 cwt. sulphate of ammonia per acre	13	11	0	6	16	0
No. 7.—6 cwt. super., 1 cwt. sulp. amm. and 1 cwt. sulp. potash per acre	12	10	0	5	15	0
No. 8.—3 cwt. market garden	7	17	2	1	2	2
No. 9.—3 cwt. basic superphosphate	7	17	2	1	2	2

THORPDALE.

Limed—1 ton per acre.

—	Yield.			Increase per acre due to Manure.		
	Tons	cwt.	qrs.	Tons	cwt.	qrs.
No. 1.—3 cwt. super. per acre	9	15	0	3	15	0
No. 2.—6 cwt. super. per acre	11	10	0	5	10	0
No. 3.—9 cwt. super. per acre	10	0	0	4	0	0
No. 4.—6 cwt. super., 1 cwt. sulphate of potash per acre	10	0	0	4	0	0
No. 5.—No manure	6	0	0	..		
No. 6.—6 cwt. super., 1 cwt. sulphate of ammonia per acre	8	0	0	2	0	0
No. 7.—6 cwt. super., 1 cwt. sulp. amm. and 1 cwt. sulp. potash per acre	8	5	0	2	5	0
No. 8.—3 cwt. market garden	10	5	0	4	5	0
No. 9.—3 cwt. basic superphosphate	6	0	0	..		

THORPDALE.

Unlimed.

—	Yield.			Increase per acre due to Manure.		
	Tons	cwt.	qrs.	Tons	cwt.	qrs.
No. 1.—3 cwt. super. per acre	8	0	0	2	15	0
No. 2.—6 cwt. super. per acre	9	10	0	4	5	0
No. 3.—9 cwt. super. per acre	9	7	2	4	2	2
No. 4.—6 cwt. super., 1 cwt. sulphate of potash per acre	9	10	0	4	5	0
No. 5.—No manure	5	5	0	..		
No. 6.—6 cwt. super., 1 cwt. sulphate of ammonia per acre	9	10	0	4	5	0
No. 7.—6 cwt. super., 1 cwt. sulp. amm. and 1 cwt. sulp. potash per acre	8	10	0	3	5	0
No. 8.—3 cwt. market garden	8	2	2	2	16	2
No. 9.—3 cwt. basic superphosphate	6	10	0	1	5	0

TRENTHAM.

Limed 1 ton per acre.

—	Yield.			Increase per acre due to Manure.		
	Tons	cwt.	qrs.	Tons	cwt.	qrs.
No. 1.—3 cwt. super. per acre	8	2	2	4	5	0
No. 2.—6 cwt. super. per acre	8	10	0	4	12	2
No. 3.—9 cwt. super. per acre	8	0	0	4	1	2
No. 4.—6 cwt. super., 1 cwt. sulphate of potash per acre	8	5	0	4	7	2
No. 5.—No manure	3	17	2		..	
No. 6.—6 cwt. super., 1 cwt. sulphate of ammonia per acre	8	10	0	4	12	2
No. 7.—6 cwt. super., 1 cwt. sulp. amm. and 1 cwt. sulp. potash per acre	8	0	0	4	1	2
No. 8.—3 cwt. market garden	5	12	0	1	14	2
No. 9.—3 cwt. basic superphosphate	4	10	0	0	12	2

TRENTHAM.

Unlimed.

—	Yeill.			Increase per acre due to Manure.		
	Tons	cwt.	qrs.	Tons	cwt.	qrs.
No. 1.—3 cwt. super. per acre	7	12	2	4	5	0
No. 2.—6 cwt. super. per acre	7	15	0	4	7	2
No. 3.—9 cwt. super. per acre	8	0	0	4	12	2
No. 4.—6 cwt. super., 1 cwt. sulphate of potash per acre	7	15	0	4	7	2
No. 5.—No manure	3	7	2		..	
No. 6.—6 cwt. super., 1 cwt. sulphate of ammonia per acre	7	15	0	4	7	2
No. 7.—6 cwt. super., 1 cwt. sulp. amm. and 1 cwt. sulp. potash per acre	7	10	0	4	2	2
No. 8.—3 cwt. market garden	5	5	0	1	17	2
No. 9.—3 cwt. basic superphosphate	4	7	2	1	0	0

From the foregoing tables it will be seen that substantial increases were produced by all manures in each of the fields. The point now to be considered is, which manure gave the best average return considering its cost? That can only be arrived at by taking an average of the performance of each particular dressing as set out in the following table. Manure costs have been calculated on Melbourne costs as follows:—Superphosphate, £4 10s. per ton; basic super., £4 15s. per ton; market garden manure, £8 per ton; sulphate of ammonia, £18 per ton; sulphate of potash, £15 per ton.

AVERAGE RETURNS FROM MANURES AT FOUR CENTRES.

Limed and Unlimed.

—	Average Yield.	Average Increase.	Cost per acre Manure.	Cost per ton Increase.
	T. c. q.	T. c. q.	£ s. d.	s. d.
No. 1.—3 cwt. super. per acre	9 4 2	4 2 0	0 13 6	3 4
No. 2.—6 cwt. super. per acre	9 19 3	4 17 1	1 7 0	5 7
No. 3.—9 cwt. super. per acre	9 17 2	4 15 0	2 0 6	8 7
No. 4.—6 cwt. super., 1 cwt. sulphate of potash per acre	10 3 0	5 0 2	2 2 0	8 5
No. 5.—No manure	5 2 2	..	..	..
No. 6.—6 cwt. super., 1 cwt. sulphate of ammonia per acre	10 12 0	5 10 2	2 5 0	8 2
No. 7.—6 cwt. super., 1 cwt. sulp. amm. and 1 cwt. sulp. potash per acre	10 9 2	5 7 0	3 0 0	11 3
No. 8.—3 cwt. market garden	7 4 0	2 1 2	1 4 0	11 9
No. 9.—3 cwt. basic superphosphate ..	6 12 0	1 9 2	0 14 3	9 2

It will be seen that, during the past season, the cost per ton increase varied from 3s. 4d. to 11s. 9d. At first glance this would seem to indicate that the light dressing of super., viz., 3 cwt. per acre, was the most effective; but, if we take the total value of the crop produced, and calculate this to be worth £4 per ton, it will be seen that the highest acre returns in terms of £ s. d. are procured by some of the more expensive dressings, as shown hereunder:—

—	Average Yield.	Cost of Manure.	Value of crop at £4 per ton.	Net Increase.
	T. c. q.	£ s. d.	£ s. d.	£ s. d.
No. 1.—3 cwt. super. per acre	9 4 2	0 13 6	36 18 0	15 14 6
No. 2.—6 cwt. super. per acre	9 19 3	1 7 0	39 19 0	18 2 0
No. 3.—9 cwt. super. per acre	9 17 2	2 0 6	39 10 0	16 19 6
No. 4.—6 cwt. super., 1 cwt. sulphate of potash per acre	10 3 0	2 2 0	40 12 0	18 0 0
No. 5.—No manure	5 2 2	..	20 10 0	..
No. 6.—6 cwt. super., 1 cwt. sulphate of ammonia per acre	10 12 0	2 5 0	42 8 0	19 13 0
No. 7.—6 cwt. super., 1 cwt. sulp. amm. and 1 cwt. sulp. potash per acre	10 9 2	3 0 0	41 18 0	18 8 0
No. 8.—3 cwt. market garden	7 4 0	1 4 0	28 16 0	7 2 0
No. 9.—3 cwt. basic superphosphate ..	6 12 0	0 14 3	26 8 0	5 3 9

In addition, there would be the greater residuum from the heavier dressing to benefit the succeeding crop.

The results obtained from liming, while not supplying any startling figures, indicate a general improvement from its application. The actual

average return from liming works out, on the above returns from the four centres, at—

Limed.		Unlimed.	Increase per acre.
T. C.2.		T. C. 2.	T. C. 2.
£7 4s. per acre	...	£6 12s. per acre	... 12s.

Consideration, however, must be given to the fact that, although the actual tonnage increase was not great, the improvement in quality of the tubers was marked, and there was considerably less damage from disease where lime was applied.

POULTRY FEEDING EXPERIMENT.

State Research Farm, Werribee.

(W. C. Rugg, Chief Poultry Expert, and W. O. Pederick, Poultry Foreman).

An experiment was recently carried out to test the advisability of allowing White Leghorns a free choice of the various foods—usually fed to birds for egg production, as compared with two other systems of feeding in operation at the State Research Farm, namely—

(*a*) Dry mash kept in hoppers always available, chaffed green stuff given at mid-day and grain fed at night in the litter.

(*b*) Wet mash fed in troughs in the morning, chaffed green stuff at mid-day and grain fed in the litter at night.

The test commenced on 1st April, 1923, and concluded on 24th March, 1924—a period of 51 weeks. One hundred and eight White Leghorn pullets were divided into three lots of 36 birds, and each lot was in quality about equal to an ordinary farm flock. None of the birds used was bred from single-mated hens. The pullets were bred from pens of hens mated to selected cockerels and the progeny of each cockerel was toe-marked.

As it has been our experience that the daughters of some male birds lay better than others (even when the male birds are full brothers) care was taken that the same number of daughters of each male bird used in the breeding pens was placed in each of the experimental pens and every effort was made in the selection of the pullets to have the three pens as even as possible, in age, size, quality and breeding.

Weight of the Birds.

At the commencement of the Test the 108 pullets weighed 337½ lbs., an average of 3 lbs. 2 oz. per bird, and their average weight at

the end of four months and at the conclusion of the Test is shown in the following Table:—

Date.	No. 1.—Free Choice.		No. 2.—Dry Mash.		No. 3.—Wet Mash.	
	No. of Birds.	Weight.	No. of Birds.	Weight.	No. of Birds.	Weight.
		lbs. oz.		lbs. oz.		lbs. oz.
April 1st	36	3 1	36	3 3	36	3 2
August 2nd ..	36	3 11½	36	3 10	36	3 9
March 24th ..	36	3 6½	36	3 7	36	3 7¼

System of Feeding.

No. 1. *Free Choice Pen.* All the different varieties of food were placed in separate hoppers which were vermin and sparrow-proof. The foods were as follow:—Bran, wheaten pollard, oaten pollard, barley pollard, meat meal, rape seed meal, wheat, Algerian oats (not clipped) cracked maize and barley. Green stuff was always available in a wire netting basket; it consisted of green oats, green barley, rape, rye grass in winter, and lucerne in the summer. It was cut fresh every day and placed in the basket whole, not chaffed.

No. 2. *Dry Mash Pen.* The dry mash consisted of equal parts by measure of bran and wheat pollard; to every 100 lbs. of meal was added 10 lbs. of meat meal, 3 lbs. of powdered charcoal and 5 lbs. of rape seed meal. This mash was always available. Chaffed green stuff was fed at mid-day and the evening meal of grain consisted of wheat, oats, cracked maize, and barley was scattered in the scratching litter.

No. 3. *Wet Mash Pen.* The wet mash consisted of bran, wheat, pollard and chaffed green stuff, equal parts by measure, and was mixed as follows:—The bran was saturated with soup made from boiled livers; it was then dried off with pollard to a nice crumbly condition and the chaffed green stuff was added and thoroughly mixed through it. The birds were given as much as they would eat. Chaffed green stuff was fed at mid-day and the evening feed of grain, consisting of wheat, Algerian oats, cracked maize and barley was scattered in the litter. Minced raw onions were fed to each pen once a week at the rate of 1 lb. per pen. Shell grit and granulated charcoal were always available.

Housing.

The birds were housed in portion of a corrugated iron shed 120 ft. by 20 ft., 9 ft. high in front and 7ft. at the back. The shed faces east, and the north, west, and south walls are wind-proof. Windows are provided along the west wall for ventilation. The east side is closed in 2 feet up from the floor, and 1 foot down from the roof; the rest is wire netted and no curtains were used. A portion of this shed was partitioned off with wire netting and divided into three pens of equal size about 260 sq. feet—a little over 7 sq. feet to the bird. The birds were kept in the pens throughout the Test. The floor was covered with litter to the depth of about 4 inches. Dropping boards were used under the perches and dust baths were provided.

Health of the Birds.

The health of the birds was good throughout the Test; there was no noticable difference in any pen.

Monthly Consumption of Food.

Month.	Bran.	Pollard.	Oaten Pollard	Barley Pollard	Meat Meal.	Meal Rape.	Oats.	Wheat.	Barley.	Maize.	Eggs Laid.
	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.
No. 1 Pen (36 Birds) Free Choice.											
April ..	12	25	½	½	..	..	41¼	72	24¾	17	419
May ..	13¼	20	¼	½	..	..	32¼	96¾	21¾	26½	329
June ..	11¾	9½	¼	2	2½	..	48	54	14	37½	292
July ..	12¾	10¾	3½	..	11½	..	22¾	98	11¼	51¾	434
August ..	14¾	9¾	9	1	8	2½	30½	96¾	24½	25¼	669
September	16½	16½	12¾	3	5½	1	41½	108½	25½	33¾	700
October ..	23½	19¾	17¼	1¾	8	1½	50¼	103½	14	27	743
November..	21½	29¼	2¾	¾	8½	..	57½	90	26	30¾	723
December ..	20½	25	2¾	½	5¼	2½	32	91½	20	24¾	613
January ..	18½	29	1½	2½	13¾	2½	32	85	26	29¼	554
February ..	11½	19½	5½	3	3	1	63½	92	12	27½	449
March, 24th	8	15	7	2¾	1½	½	24½	70	19	26½	326
	184½	229	63	18¼	67½	11½	475¾	1,058	238½	357½	6,251
No. 2 Pen (36 Birds) Dry Mash.											
April ..	14	23½	..	..	3¾	..	18½	83	18½	..	281
May ..	13¾	23½	..	..	3½	..	22	108	22	..	287
June ..	15¾	31¾	..	..	5¾	..	25	109	..	18½	230
July ..	25¾	43½	..	..	10½	..	35	111	..	10	387
August ..	34	57	..	..	11¾	2½	28	99	..	28	704
September	33½	56½	..	..	9½	4	27	96	..	27	748
October ..	37¼	61¾	..	..	12¼	3¼	26	103	26	..	749
November..	47¾	82¼	..	..	15¾	7¾	28	106	16	..	663
December ..	29	48¼	..	..	9¾	4¾	20	110	20	..	598
January ..	28	46¾	..	..	9½	4¼	28	99	28	..	572
February ..	33	55	..	..	11	5½	50	65	36	..	519
March, 24th	27	46	..	..	9	4½	33	66	16	..	363
	338¾	575¾	..	..	112	37	340½	1,155	182½	83½	6.101
No. 3 Pen (36 Birds) Wet Mash.											
April ..	25	40	..	..	4½	..	19½	88	19½	..	398
May ..	29½	49	..	..	10½	..	20	96	20	..	372
June ..	30	48	..	..	13½	..	20	88	..	14½	256
July ..	30	50	..	..	16	..	30	95	..	9	419
August ..	32	52	..	..	20	..	25	90	..	25½	623
September	27½	45½	..	..	16	..	26	92½	..	26	702
October ..	27	54	..	..	18	..	24½	100	24½	..	775
November..	27	47	..	..	16	..	28	102	15	..	687
December ..	26½	47½	..	..	12	..	20½	111½	20½	..	701
January ..	27½	49½	..	..	18	..	27	95½	27	..	694
February ..	28½	44	..	..	18	..	47	61	34	..	501
March, 24th	24	32	..	..	10	..	33	66	16½	..	375
	334½	558½	..	..	172½	..	320½	1,085	177	75	6,503

Food Consumed and its Cost.

Food.	Price.	No. 1., Free Choice.		No. 2., Dry Mash.		No. 3., Wet Mash.	
		Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
		lb.	£ s. d.	lb.	£ s. d.	lb.	£ s. d.
Bran ..	£6 per ton ..	184½	0 11 0½	338¾	1 0 3½	334½	1 0 0½
Pollard ..	£7 per ton ..	229	0 16 0	575¾	2 0 3½	558½	1 19 1
Oat Pollard	2s. 6d. per bus.	63	0 7 10½	..	..	..	..
Barley Pollard ..	2s. per bus. ..	18¼	0 1 9½	..	..	..	..
Meat Meal..	£1 per cwt. ..	67½	0 12 0	112	1 0 0	172½	1 8 9
Rape Seed Meal ..	7s. 6d. per cwt.	11½	0 0 9	37	0 2 5½	..	..
Oats ..	3s. 6d. per bus.	475¾	2 1 7½	340½	1 9 9½	320½	1 8 0½
Wheat ..	4s. 9d. per bus.	1,058	4 3 9	1,155	4 11 5	1,085	4 5 10½
Barley ..	3s. 3d. per bus.	238½	0 15 6	182½	0 11 10	177	0 11 6
Maize ..	6s. per bus. ..	357½	1 18 3½	83½	0 8 11	75	0 8 0
Totals ..	.. ..	2,703½	11 8 7½	2,825	11 5 0	2,723	11 1 3½

Eggs Produced and their Value.

Month.	Average Price per dozen.	No. 1., Free Choice.		No. 2., Dry Mash.		No. 3., Wet Mash.	
		No. of Eggs Laid.	Value.	No. of Eggs Laid.	Value.	No. of Eggs Laid.	Value.
	s. d.		£ s. d.		£ s. d.		£ s. d.
April	2 4½	419	4 2 11	281	2 15 7¼	398	3 18 9¼
May	2 6	329	3 8 6½	287	2 19 9½	372	3 17 6
June	2 4¼	292	2 17 3½	230	2 5 1½	256	2 10 2¾
July	1 11	434	3 9 3¾	387	3 1 9¾	419	3 6 11
August ..	1 1¼	669	3 1 6¾	704	3 4 9¼	623	2 17 4
September ..	1 1	700	3 3 2¼	748	3 7 6¼	702	3 3 4½
October ..	1 1	743	3 7 1	749	3 7 7¼	775	3 9 11½
November ..	1 1¾	723	3 9 0½	663	3 3 3¾	687	3 5 7¼
December ..	1 3	613	3 3 10¼	598	3 2 3½	701	3 13 0¼
January ..	1 3¼	554	2 18 8	572	3 0 7	694	3 13 6
February ..	1 9	449	3 5 5¼	519	3 15 8¼	501	3 13 0¾
March, 24th ..	1 10	326	2 9 9½	363	2 15 5½	375	2 17 3¾
Totals ..	..	6,251	38 16 8¾	6,101	36 19 6¾	6,503	40 6 7

Summary.

Pen.	Average No. of Eggs per Bird.	Return per Bird.	Mash.	Cost Grain.	Total.	Profit over Cost of Feed.
		£ s. d.	s. d.	s. d.	s. d.	s. d.
No. 1.—Free Choice ..	173·64	1 1 6¾	1 4½	4 11½	6 4	15 2¾
No. 2.—Dry Mash ..	169·47	1 0 6½	2 3¾	3 11¼	6 3	14 3½
No. 3.—Wet Mash ..	180·64	1 2 4¾	2 5¼	3 8½	6 1¾	16 3

Conclusions.

The results obtained in this experiment with the No. 1 Pen (Free Choice) indicate that White Leghorns can be trusted to balance their own ration and produce eggs economically.

Although they laid seven eggs per bird less, and cost 2¼d. per bird more to feed for the twelve months than the pen fed on the wet mash, it must be remembered that there was a considerable saving in labour in the feeding of the No. 1 Pen, as the feed hoppers had to be replenished on an average only twice a month; whereas, the wet mash for No. 3 Pen had to be prepared and fed to the birds every morning, and the grain mixed and fed to them every evening.

A reference to the table showing the monthly food consumption should be sufficient to break down the prejudice existing amongst a number of poultry-keepers against the use of Algerian oats. The oats used in this experiment were only fair average quality feed oats, straight from the harvester, not clipped or graded; yet the birds in No. 1 (Free Choice) Pen ate more of them than of either maize or barley.

It was very noticeable during the test that the quantity of maize consumed varied with the weather. The highest consumption for the year was in July, which was the coldest and wettest month of the Test.

Rape seed meal was not placed in the pen till 1st August. From that date till the end of the test, there was only one month in which they did not eat some of it. This meal is readily eaten by the birds when placed in the dry mash.

The fact that the birds in No. 1 Pen (Free Choice) consumed 1,556 lbs. more grain than mash may be accounted for by the cold weather during the winter and by the very mild summer.

It was noted that the No. 1 Pen (Free Choice) consumed a much larger quantity of green stuff than either of the other two pens, and a considerable portion of it was eaten the last thing before the birds went to roost. In view of this fact, it was decided to feed green stuff after the grain feed at night to all the birds at the Research Farm, and this has resulted in a great improvement in the number of eggs laid.

CORRECTION.

In a footnote to the Report of the Nhill Crop and Fallow Competition printed in this Journal for April last (page 223), an error occurred. The note should have read " . . . . . The cost of copper carbonate has been reduced FIFTY per cent."

RUPANYUP FALLOW COMPETITION.

Report of the Judge, H. A. Mullett, B.Ag.Sc., Senior Inspector of Agriculture.

Normally, the fallows are judged during the month of December, when their moisture content usually reflects the preparation given them, and, to the initiated, their condition is some indication of their power to retain the moisture over the dry summer months. A heavy thunder storm during the judging in December, led to the work being deferred until March, when it was expected that drier conditions would prevail. But downpour followed downpour during January and February, with the result that in the middle of March, although no rain had fallen for several weeks, the sub-soils were all in an almost saturated condition, hence the degree of saturation was not necessarily any indication of the thoroughness of the work. The contest, therefore, loses some of its educational value. On the other hand, in the high moisture content of the fallows, two of which contained 24.9 per cent. of water, wheat-growers will find cause for much satisfaction. Provided that a good mulch has been put on to prevent undue evaporation, a wheat crop is practically assured with but very little rain during the growing period. Then again there has been an excellent opportunity to kill weeds by light cultivation following on the rains. Naturally enough, "paddy melons," and other summer-growing weeds made their appearance on many fallows, but caused no trouble when tackled early enough with the scarifier fitted with the "knife" attachment. In a few cases, where they have been allowed to develop unduly, it will be difficult to avoid discing the land. A suggestion has been made recently that it ought to be possible to fit a small knife attachment to the harrow to cope with these and other strong-rooted plants while in the seedling stage. It is understood that the device has been tried successfully, but it is emphasized that it would be essential to harrow while the plants are very small, otherwise they would clog the harrows unduly. Recently a knife attached to a spring-toothed cultivator was noticed in the Goulburn Valley. It was doing satisfactory work.

Results.

OPEN SECTION—ALL COMPETITOR'S FALLOW TO BE SHOWN (MINIMUM 100 ACRES).

The first prize in the open section was awarded to Mr. D. H. Jones, who secured 94 points; Messrs. Hemphill Bros. were second, with 93; and Mr. J. P. Loats third, with 92. Mr. D. Jones had fallowed 300 acres of even black soil. One hundred acres had been ploughed at the end of March to between 3 and 4 inches deep, and the balance was winter-fallowed between August and September. Then the whole was harrowed in September, and scarified later in the same month; subsequently another harrowing was given and then a scarifying in November. Some additional cultivation had been given between this time and March, as the fallow was nicely mulched to between 2 and 3 inches deep, and contained but a few weeds. The "bottom" was firm,

but showed some irregularities. The moisture content, as tested by a soil auger to 2 feet deep, was very high.

Messrs. Hemphill Bros'. fallow was in excellent order, but contained slightly less moisture than that of the winner; otherwise there was little to choose between them. The mulch was evenly distributed and of mellow texture, and few weeds were present save in one small patch. The soil below the mulch and above the lowest point reached by the plough was well consolidated. In all 315 acres were submitted to the judge—185 acres of summer fallow, and 130 acres winter fallow. The best paddock of summer fallow was ploughed in March and April shallowly, then harrowed. In August it was worked over with a skim-plough, then harrowed; in October scarified and harrowed, and after harvest harrowed. The winter fallow was ploughed in July and August, and harrowed. In October it was scarified, in November harrowed, also again after harvest.

Mr. J. P. Loats showed 280 acres of brown soil, part summer-fallowed, part winter-fallowed. The fallow was in good condition, though a point or two was deducted because the mulch was thought to be rather too deep.

DETAILS OF AWARD.

Competitor.	Moisture.	Mulch.	Weeds.	Cultivation.	Total.
Possible Points	25	25	25	25	100
D. Jones	25	24	22	23	94
Hemphill Bros.	22	24	23	24	93
J. P. Loats	23	22	24	23	92
C. Carra	23	21	22	23	89
W. Newall	24	20	24	21	89
R. J. Jackson	19	23	22	22	86
G. L. Crommie	25	20	18	22	85

SECTION FOR REPATRIATED SOLDIERS—MINIMUM, 40 ACRES.

M. H. G. Swan was placed first and gained 96 points; Mr. F. Nicholson was second, with 94; Mr. Coute was third, with 87. The winning fallow—160 acres—was in excellent condition; 25 acres had been in fallow two years, while the balance was well worked summer-fallow. The moisture content was very high, and the mulch, though in parts rather too fine for the class of soil, had been placed on with care and judgment. Weeds were absent. The following will serve to indicate the thorough manner in which the land has been worked. A paddock of 80 acres was ploughed in March and April, then re-ploughed early in September, subsequently it was harrowed twice, then scarified, then harrowed and re-scarified, and finally harrowed "during hay-carting time." At the end of February, following on rain, a further harrowing was given. The second prize fallow was notable for an excellent mulch of mellow texture; the "bottom" was well consolidated, but showed evidence of ridging. A green tinge of weeds was showing, but this could be sheeped easily. Mr. Coute's fallow seemed deficient in moisture.

DETAILS OF AWARD.

Competitor.	Moisture.	Mulch.	Weeds.	Cultivation.	Total.
Possible Points	25	25	25	25	100
H. G. Swan	25	22	24	23	94
N. Nicholson	24	23	23	23	93
—. Coute	20	22	21	22	85

Fallowing with Tractors.

Numerous tractors have been purchased by Wimmera farmers. Where several teams are kept, it looks as if a tractor may be employed with advantage to replace some of them, but it cannot be said that the stage has been reached when horses can be dispensed with altogether, because no tractor on the market is an all-weather machine. Ploughing and cultivating with a tractor cannot be done as effectively as with horses, if it means towing an uncontrolled implement behind the tractor driver. Yet that is what many are attempting to do. Such work must be imperfect, and such imperfections will be reflected inevitably in the yields. Most implements can be modified so that the levers can be controlled from the tractor; but, as yet, few have made the necessary modifications. Is is to be hoped that the advent of the tractor will not be signalized by any serious falling away from the high standard of cultivation for which the Wimmera is famous.

MEDITERRANEAN FRUIT FLY

(*Ceratitis capitata*).

By J. M. Ward (Superintendent of Horticulture).

Its Recent Appearance in Victoria.

Unfortunately for Victorian fruit-growers, the Mediterranean Fruit Fly has again made its appearance in this State.

On 29th December, 1923, the Department of Agriculture received a report from Mr. Davidson (Orchard Supervisor stationed at Mildura), to the effect that he had found some apricots containing fruit-fly larvae. During the previous July the fly had been discovered in oranges in the same district, and the fruit on these trees—some half dozen or so—was immediately picked and destroyed, and no further trace of the pest has since been found in that particular block. Still, judging by later discoveries, it must have been present at this period in other parts of the district, but escaped the keen eye of the District Orchard Supervisor until a later date.

During January and February of the present year, it was located in 120 orchards in the Mildura district, and in March was discovered in

the Goulburn Valley. Although it was found to be widely spread, in only one instance were these flies in any number, and that was in a non-commercial peach orchard on the bank of the River Murray, some 5 miles from Cobram; here it was very difficult to find a sound peach. In the writer's opinion the pest had been in this orchard for a period of at least two years before being located by a departmental officer. With this one exception, not more than a few bushel cases of fruit affected with fly have been found in any one orchard, and in practically every instance the pest was detected by one of the orchard supervisors shortly after it had made its appearance in an orchard, so very keen was the inspection; in fact, in the majority of fly-infested orchards only a dozen or so fruits were affected.

Mildura being an isolated fruit district and fruit from there, with the exception of grapes and figs, having been marketed by the end of January, it was decided that the whole of the remainder of the fruit (grapes and main-crop oranges and lemons excepted) should be destroyed, with a view of wholly eradicating the pest from Mildura and the State. Such action, no doubt, had the effect of destroying thousands of eggs and larvae which would have escaped the notice of inspectors, but, unfortunately, it did not totally exterminate the pest. At the present time, however, few, if any, fruit flies can be found in the district, a close search during the past six weeks failing to locate any.

In the Goulburn Valley, which is the chief peach-growing district of Victoria, it was decided that the fruit crop should be harvested by 8th April, and this requirement was carried out fairly satisfactorily within a few days of this date.

In undertaking work of this nature, the greatest problem of all is to have "that last peach, quince, or plum," or whatever is the nature of the fruit, gathered from the tree, so as to eliminate any possible host in which the fly might reproduce itself. Another source of trouble is the few odd trees in the town or farm garden. Such trees are usually greater breeding grounds for insect pests and diseases than the combined commercial orchards in a fruit district.

The previous outbreak of fruit fly in Victoria was some eighteen years ago, when the pest was fought and conquered. At that time, of course, there was not the area of orchards under cultivation, nor the chain of fruits, as is the case at the present time; therefore the problem at this juncture is a very much harder one.

Occasionally one hears the statement that the Mediterranean Fruit Fy will not winter in Victoria, and therefore will naurally die out during the winter months. Such statements are made only by those who have not had a personal experience of fighting this pest, and know little, if anything, of its life history. Further, the fact remains that the fly actually did winter here last year, and possibly one or two winters before that.

In the Stanthorpe (Queensland) district the Queensland Fruit Fly (*Chætodacus Tryoni*) was not killed in the pupal stage by heavy frosts, and even snow last year; and this particular fly is not supposed to withstand cold weather to the same extent as the Mediterranean fly. It may, therefore, be most positively stated that frosts will not eradicate the fruit-fly pest; if such were the case, our problem would be a comparatively easy one.

Whilst the writer held a position in the Department of Agriculture, Queensland, an arrangement was made with Mr. Henry Tryon (Entomologist), during March and April of 1923, to carry out some cold storage experiments with fly-infected apples with a view of determining what effect cold storage would have upon the larvae of the Queensland Fruit Fly (*Chætodacus Tryoni*). In this experiment Mr. Tryon, who was assisted by Mr. F. G. Holdaway, B.Sc., furnished a report which states:—"The fruit was placed in cold storage at 5 p.m. on 26th March, 1923, and at intervals of every 24 hours or thereabouts (with certain exceptions) twelve apples were submitted and duly examined Their condition on examination is set forth in the following tabulated statement:—

Date.	Temp. of Cold storage.	Apples infested.	Eggs.	Larvae.	Approx. size of larvae.
27.3.23	40 degrees ..	5 out of 14 = 37·7 %	1	..	
,,	,, ..	..	..	x 6	1 m.m.
,,	,, ..	..	..	x 1	1 m.m.
,,	,, ..	..	..	x 5	1 m.m.
,,	,, ..	..	1	x 2	1½ m.m.
28.3.23	Temp. not supplied	2 out of 12 = 18·6 %	..	x 10	2 m.m.
			..	x 6	2½ m.m.
29.3.23	37 deg. ..	4 out of 12 = 33·3 %	..	x 4	3·3½ m.m.
,,	,, ..	..	..	x 3	1½ m.m.
,,	,, ..	..	..	x 2	1½ m.m.
,,	,, ..	..	..	x 14	3 m.m.
30.3.23 to 4.4.23 (inclusive)	No apples brought into office for examination				
5.4.23	42 deg. ..	6 out of 12 = 50 %	..	3	2½ m.m.
,,	,, ..	..	..	4	2 m.m.
,,	,, ..	..	4	..	
,,	,, ..	..	..	19	2·3 m.m.
,,	,, ..	..	3	..	..
,,	,, ..	.. Apple with only one trial sting			
6.4.23	34 deg. ..	4 out of 12 = 33·3 %	..	9	2 m.m.
		Three apples with only trial stings			
9.4.23	34 deg. ..	4 out of 12 = 33·3 %	..	10	3 m.m.
,,	,, ..	..	..	8	3 m.m.
,,	,, ..	..	..	8	7 m.m.
,,	,, ..	..	..	9	2·3½ m.m.
				10	6·7 m.m.

Larvae marked x indicates alive.

All larvae obtained on and after 5th April, 1923, were dead, and brown or black in colour—showing that they had been dead some time.

"From this the following facts are elicited:—

(1) Thirty-four per cent. (34%) of the apples manifested fruit-fly infestation.

(2) This fruit-fly infestation on the day following submission to cold storage was represented exclusively by insects either in the egg phase or life, or by young maggots (1 to 1½ m.m. in length) that had recently hatched from eggs.

(3) These insects survived and grew slowly until at least the expiration of two or three days with augmented damage, but seldom, if ever, attaining a degree to render the fruit unsaleable.

(4) They had, however, all died at a date between 30th March and 8th April, indicating that the duration of cold storage necessary to destroy them was not less than four days nor more than eight days. (Note.) No fruit fly samples having been through inadvertence (Easter holidays) tendered from 30th March to 3rd April inclusive (five days), the precise time when death ensued could not be more accurately determined.

(5) The temperature of cold storage fluctuating, moreover, from 34 deg. Fahr. to 42 deg. Fahr., the optimum between these limits for securing fatal results was unascertainable.

(6) Although, owing to varying temperature conditions of the cold storage and the non-continuous supply of apples for examination, no exact conclusions could be arrived at, still, it is indicated—as already to be inferred from the data of previous experiments—that fruit-fly larvae infesting fruit, and fruit-fly damage in fruit, may be brought to a standstill by cold storage for a period of not less than ten days, possibly much less.

(7) It is also evident from the condition of the apples under consideration, as submitted to us, that it is possible (for the observant orchardist) to recognize fruit-fly injury at a very early stage in its occurrence, and so to treat fruit by cold storage when it is practically without any outward blemish and with only the slightest tissue injury to occasion notice and remark."

In addition to the above, some recent experiments—of all stages of existence of the insect—carried out at the Government cool stores, Melbourne, by Mr. Meeking (Senior Fruit Inspector) in conjunction with Mr. French (Entomologist) with some infected oranges, elicited the following facts:—

Larvae.—Temperatures of 32 deg. Fahr. and 37 deg. Fahr. were used, and experiments were carried out in the storage of samples at each of these temperatures for one week, two weeks, and three weeks. Twelve tests of 36 oranges—three fruits in each test, each orange containing from 6 to 20 larvae—were made, with the result that in every instance the larvae were destroyed. Those placed in storage at 37 deg. Fahr. for seven days only, although immobile, had not changed colour as was the case with the specimens stored at 32 deg. Fahr., but none of the larvae revived, and they became discoloured shortly after removal from storage.

Pupae.—One experiment was made with the insects in the pupal stage as follows:—On 12th February, 1924, twelve larvae were placed in a separate jar, containing soil; they immediately burrowed into the soil and pupated a few hours later. The same day the jar containing the pupæ was placed in storage at a temperature of 32 deg. Fahr.; it was removed on 27th February, 1924, and was filled with water on 1st March, 1924. After having been left in the jar for three days, the water was

carefully drained off and the jar (still containing soil and pupæ) was placed in a glass house. A self-registering thermometer was installed and a record of the maximum, minimum and mean temperature was kept. The temperature ranged from a minimum of 53 deg. Fahr. to a maximum of 92 deg. Fahr. On 22nd March—eighteen days later—eight flies emerged from the pupæ—two females and six males.

Perfect Insect.—Twelve flies which had been bred out in the departmental offices were placed in storage in a specimen jar for 48 hours at a temperature of 32 deg. Fahr.—not quite freezing point. On removal, the insects were quite immobile with no apparent signs of life. The jar in which they were contained was then placed in a window where a supply of sunlight was available, and all the flies recovered within 24 hours and remained fully active until destroyed some days later.

The results of these experiments with the Mediterranean Fruit Fly show that the insect can be destroyed in the larval stage by exposure to a low temperature of 32 deg. Fahr., but in the pupal stage cold storage at this temperature had no effect. It is intended to conduct further cold-storage experiments with this insect in greater detail.

Methods of Eradication.

The Fruit Fly is one of the hardest of all insect pests to eradicate once it becomes established in any country. In the early stages of its life—egg stage—it is very difficult to detect, particularly in such fruit as oranges. After emerging from the pupæ the female fly usually feeds for several days upon fruit juices and similar substances of a sweet nature, before commencing to deposit eggs. She then selects her fruits, and with the ovipositor punctures or stings the fruit to the depth of about one-sixteenth of an inch or less and deposits three or more eggs. The total number of eggs that may be laid by a fly ranges from 60 to 300. In a few days or longer, according to climatic conditions, larvae or maggots hatch out, and in the course of some ten to twenty days the fruit they attack becomes quite unfit for human consumption. The fruit, being completely ruined, will fall to the ground, and the maggots find their way to the soil, where they pupate, and later on emerge as perfect insects to continue the destructive work. Occasionally the larvae leave the fruit before it drops to the ground, especially in the case of nectarines.

The fly in its pupal stage remains in the ground from ten to fifteen days during summer months, and from 25 to 50 or probably more in the winter. The fly itself lives for a period of from 30 to 75 days in summer, and this period may be shortened during winter. It quickly dies after egg laying is completed.

There are a number of control measures that may be taken to prevent the spread of this pest. The most important of all is to have all fly-infested fruit destroyed before the larvae leave the fruit, otherwise encouragement is given for further broods. The destruction of such fruits should be thoroughly effective; they should be burnt, boiled, or buried to a depth of not less than 30 inches.

Early in the present year the writer came across a grower who was treating peaches containing larvae by merely throwing out a few shovelfuls of earth, tipping the peaches into this shallow hole and covering them over with a few inches of soil. This is in keeping with placing a broody hen on some fertile eggs. Thoroughness in destroying infected fruit is the keynote of success.

Whilst the writer was in the Queensland Department, fair success was obtained in the use of a lure, made by Mr. A. W. Harvey, of Brisbane, and known as "Harvey's Fruit Fly Lure." We have given this device, together with "home-made" lures, a trial in Victoria, with varying results. In four days, 2nd May to 6th May, in the orchard near Cobram previously mentioned 422 flies were caught in a glass fly-trap with "Harvey's Lure," and 147 were caught in some kerosene placed in a sardine tin. The greater percentage of those caught with "Harvey's Lure" were female flies, whilst all those in the kerosene were males. A few females, however, were caught in kerosene in other places. A number of flies were trapped with a lure made of honey, orange juice, and water.

The formula of a lure recommended by Mr. J. L. Newman, Entomologist of Western Australia, is as follows:—

Pollard, 4 lb.
Molasses (optional), 4 oz.
Arsenate of Lead (optional), 5 oz.
Powdered borax, 8 oz.
Water to make 4 gallons.

After mixing the composition should be allowed to stand for two hours before using.

The arsenate of lead should be mixed with water separate from the other ingredients, then added.

According to Mr. Newman, it is the pollard that attracts the fly; therefore it is hardly necessary to add the arsenate of lead or the molasses. The borax is used to prevent the pollard solution from fermenting. A little of the mixture is placed in traps, such as the commercial fly-traps, or tins (marginal-edged) which should be suspended by wire and placed in trees in various parts of the orchard. Mr. Newman states that this mixture attracts a large percentage of female flies. Whatever lure is used, the traps should be attended to every few days, and the material renewed. Every grower, in northern Victoria at any rate, should consider it his duty to have a number of traps scattered amongst his trees. By doing this, there is every likelihood of any odd fruit flies, which may be present, being captured.

Sprays made according to various formulae have also been tried here with a view of poisoning the insects when they feed. Owing to the very limited number of flies in the orchard, in which the experiments were made, I am not in a position to state whether these were successful or not, but it is considered that good results were achieved.

Another mixture recommended by Mr. J. N. Newman was also tried. It consists of the following ingredients:—

The juice of one dozen average-sized ripe oranges (or the equivalent in essence), 4 lb. molasses, 4 or 5 oz. paste arsenate of lead (powdered arsenate of lead, 2 to 2½ oz.) sufficient water to make up 4 gallons. (Other citrus fruit may be used when oranges are not available.)

Method of making:—Squeeze out the juice of the oranges into a kerosene tin or other vessel. Dissolve the molasses in 1 gallon of water, then add fruit juice. To this mixture add the arsenate of lead reduced by the addition of water to the consistency of milk. Mix the three ingredients well together, adding sufficient water to make 4 gallons. When using, keep well stirred.

The purpose of applying such a spray as this is to provide poisoned food for the fly when it emerges from the pupa stage and before egg-laying commences. It is not necessary to spray the whole of the tree—

a few branches will suffice. Portion of the material should be applied to the underpart of the foliage. Applications of the spray must be applied at intervals of every two or three weeks.

Growers are advised, during the fruit season, to keep the soil immediately surrounding the tree free of weeds and other such rubbish, so that fallen fruit can be easily detected and gathered.

Further information on the fruit fly is outlined, together with coloured illustrations of the insect, on a wall-sheet recently published by the Department of Agriculture. Copies may be had upon application to the Horticultural Division.

TOMATO DISEASES.

By C. C. Brittlebank, Biologist.

"Black Dot" Root Disease.

For the past fifteen years this disease has caused considerable loss to tomato-growers. Infection generally takes place during November and December, or even earlier in the warmer parts of the State, but it is not till some time later that the plants exhibit those symptoms of attack commonly associated with root diseases. Affected plants are stunted; the lower leaves droop, turn yellow, and either fall or wither on the plant. All the upper leaves and growing portions become a pale green or a sickly yellowish-green; a gradual failing of the plant continues, and it soon dies.

If an affected plant be pulled up, the root system and base of the stem will be found to be dry and shrivelled, and many of the roots stripped of their cortical covering, the dry woody core alone remaining. Other roots will be found still retaining the outer covering, which may be easily removed by slight pressure or by slipping it off the central woody core.

Minute black dots, about the size of tobacco seed, will be seen upon the woody core and outer surface of the roots. If the dry, woody stem of a diseased plant be cut through slightly above the ground level the black specks will be seen in the larger vessels. Within the hollow stem there is almost always a considerable development of the black bodies. These, upon close observation, will be found to be covered by a number of minute black bristles. The dark dots are in fact resting bodies, their function being to carry the disease through the winter months. Sclerotia develop upon the roots earlier than upon the main woody stem of the plant. As a rule sclerotia development does not take place upon the woody stem until the plant is dead or nearly so.

CONTROL MEASURES.

Rotation of crops. Removal as soon as noticed of all diseased plants and their destruction by fire. On no account should they be left to decay or be ploughed in. The disease mentioned closely resembles, if it is not identical with, *Colletotrichum tabificum* Pethybridge.

Verticillum Wilt.

A very common disease in the cooler parts of the State. The symptoms are similar in appearance to those caused by *Fusarium lycopersici*. This wilt, however, appears earlier in the season, that is

during the cooler portion of the growing period, and dies out as the soil temperature rises.

Affected plants appear unthrifty and stunted. The first symptom is a wilting of the leaves during the warmer and brighter portions of the day; plants thus affected usually recover at night and wilt again next day.

During cool, cloudy weather the wilting is not so pronounced, but as the disease advances the lower leaves become blotched, turn yellow, and the affected plants finally die. Often, however, the plants suddenly wilt and do not recover, the leaves becoming dry and brown.

If the stem be split, internal browning may be traced from the roots upward, often extending to the top of the plant. This disease is more common in soils which contain a large amount of organic matter than in poorer clay loams.

CONTROL METHODS.

Rotation of crops, together with the collection and destruction by fire of all diseased material.

American Tomatoes Tested for Resistance to Fusarium Wilt under Victorian Conditions.

The Department of Agriculture last year imported seed of the Marvel, Norduke, Columbia and Norton varieties, which in certain of the United States of America proved to be resistant to attack by the wilt-producing fungus *Fusarium lycopersici*. This seed was sown at Burnley, and 10,000 plants were forwarded to growers in the following districts:—

Chapman Bros., Retreat-road, Bendigo.
H. Keek & Son, Bendigo.
E. Borley, White Hills.
E. Cahill, Epsom.
E. Somerville, Strathfieldsaye.
E. Holland, Marong.
E. A. White, Marong.
J. Wilson, Chateau Tabilk, Nagambie.
A. Brentnall, Barooga, Cobram.
E. Schnaeder, Castlemaine.

Most of these plantings were visited during the growing season by Mr. S. A. Cock, and the conditions of the plants as to disease and general cultivation and the bearing qualities noted. Forms were forwarded to the growers asking their opinion as to (A) Resistance of the plants to Fusarium and Spotted Wilts; (B) Commercial value of each variety; (C) For their remarks upon cultivation and irrigation; and (D) Comparison with commercial varieties such as "Large Red" and any suggestions on the varieties as a whole. An examination of the replies given shows that opinions were divided as to the resistance of the varieties to Fusarium Wilt. Against these general statements, plants collected and submitted to the Plant Pathologist for investigation showed no sign of Fusarium Wilt, although other diseases, viz., "Spotted Wilt," "Leaf Spot," *Sclerotinia and Rhizoctonia* were present. The answers to Question "D" showed a unanimous opinion that these varieties as a commercial proposition have proved, so far, of no value under Victorian conditions. Growers are hopeful, however, that by acclimatization and crossing with established varieties, they will be able to produce a type which will prove to be both wilt-resistant and a heavy cropper.

THE PRODUCTION AND FLUE-CURING OF TOBACCO.

G. E. Marks, Assistant Tobacco Expert.

The process of flue-curing tobacco is one which dates from shortly after the American Civil War, and is an off-shoot of the old fire-curing process of Virginia. This old process is employed in the curing of dark types of leaf, grown on much heavier soils than those sought after for the cultivation of flue-cured tobacco in our time. The lighter leaf became very popular, and has increased in popularity owing to its mildness, sweet flavour, and brighter colour, together with an absence of that creosotic odour and flavour caused by the smoky wood fires. Charcoal was afterwards used in place of wood to diminish this smoky odour. Another means was the use of stone and earth flues, and later by those made of sheet iron, which are the most commonly used to-day. These eliminate smoke completely, give a more satisfactory heat distribution, and produce tobacco of better colour and quality. Practically all of the bright plug, cut, and cigarette tobaccoes consumed in Australia are flue-cured.

The British Australasian Tobacco Company has agreed to purchase 1,500,000 lb. of Victorian-grown leaf at prices ranging from 6d. to 2s. 6d. per lb. for the next two seasons, and every effort is being made by the farmers to meet this demand. There are already 140 barns in Victoria, and the numerous applications being made to the department for plans of flue-curing barns indicate increased interest in the production of the crop.

Soils.

The inorganic materials which are to be considered in the physical make-up of soils may be divided into the following classes, according to the fineness or coarseness of texture:—(1) Coarse part, (2) sand, (3) silt, and (4) clay. We will consider briefly the properties of these different parts according to texture.

Gravel and Sand.

The coarse parts comprise all those larger than one-twenty-fifth of an inch in diameter; they may be classified in two divisions—gravel and stone. All material ranging from one-twenty-fifth to two-twenty-fifths of an inch in diameter is fine gravel; all above two-twenty-fifths of an inch in diameter is coarse gravel or stone.

Sand is divided into three classes—fine, medium, and coarse—ranging in size of particles from one-five hundredth to one-twenty-fifth of an inch in diameter. Sand, from a chemical point of view, consists, when pure, of grains of quartz or silica, and these being very hard resist physical and chemical change; it is this which accounts for its predominance in some places.

Sand, in reference to agricultural soil texture, contains particles of mineral rock other than silica. Generally, the finer the sand particles, the larger the amount of fine mineral particles other than silica, and, for that reason, more food material content.

Sands are usually more or less coloured with iron compounds. One distinguishing physical feature of sand is that the particles in a mass have little coherence, and easily fall apart when dry. Soils usually characterized as sandy contain only relatively very small proportions of

silt and clay (usually much less than 20 per cent.), the bulk consisting of sand of different grades of fineness.

Coarse sands are of little or no agricultural value on account of the following characteristics:—(1) They admit air too freely, causing rapid destruction of organic matter; (2) they permit water to pass downward too rapidly; and (3) they absorb heat very quickly, with consequent rapid evaporation of soil moisture. When such soils become hot and dry, premature ripening of the crop occurs, and sometimes even burning or drying-off results. As regards soluble compounds, such soil's absorbent and retaining powers are very slight, and in rainy seasons plant food leaches rapidly. Fine sand, on the contrary, has a greater water-holding capacity, is more compact, and therefore has less air circulation and slower destruction of organic matters, and does not lose its soluble compounds as fast as coarse sand. Fine, grey-coloured sand, containing a fair percentage of silt and a little clay with a porous clayey subsoil, is the best class of soil for yellow-coloured cigarette tobacco of the highest quality. Such soils are to be found at Pomonal and in many of the north-eastern districts.

CLAY.

Chemically, pipe-clay and blue clay are silicates of aluminium. The common clay soils are a mixture of pure clay, which is a hydrated silicate of aluminium, and a very minute sand, together with organic matter, potash, phosphoric acid, lime, and oxide of iron, which latter gives the various red and yellow shades. Clay, in reference to soil texture, includes all soils whose particles are less than one-five thousandth of an inch in diameter, and does not refer to chemical composition. Soils whose particles are of such small size, whether chemically clay or composed of other mixtures, have much the same effect on tobacco plants, producing a close, waxy-textured leaf, which is usually a heavy grade of poor quality, and not of the desired bright, silky, and elastic type suitable for flue-curing.

Iron compounds are chiefly responsible for the reddish colour associated with many of our clay soils, too much of which is detrimental to the production of yellow-coloured tobacco, producing rather a leaf which will cure from orange colour to mahogany.

In mass, clay particles possess certain characteristic properties which are directly opposite to those of sandy soils. Clay, if worked while in a wet condition, becomes puddled, and is then impervious to water and air; it becomes very plastic, and when dry does not, like sand, fall into separate particles. Further, when drying, clay shrinks and cracks considerably, and gets very hard and tough, and can be broken up finely only with great difficulty.

Kaolinite (pure clay) is a hard, stony material, and when broken up to the consistency of sand has similar physical properties, while it crushed or broken to a greater degree (less than 1-5,000 of an inch in diameter) has all the characteristics of clay.

If silica (quartz), which is a very hard material, is broken up in a similar manner and to the same consistency, it will have all the physical characteristics of clay.

SILT.

Silt particles vary in size from one-five hundredth to one-five thousandth of an inch in diameter, the size of the grains being intermediate between fine sand and clay. Silt is well illustrated in the fine

deposits seen in drains in which water has been slowly running. Silty loams contain small proportions of clay and sand, and are intermediate in their physical properties between clay and sand. Water penetrates silt more freely than it does clay, and less freely than sand. In many of our upland subsoils, silt is found lying between the surface soil and the clay below. Some of our lightest silty loam soils containing a fair proportion of sand, when drained and brought to the proper fertility, usually produce good mahogany types of tobacco.

Moisture.

The foregoing are some of the conditions influencing the granular or crumb-structure of soils, and can often be made use of by the farmer in modifying or controlling any soil, especially silty and clayey ones It is difficult to modify the structure of coarse sandy soils, but they can be very much improved by the use of organic matter.

When a fine-textured soil is alternately wet and dry, the effect is to release its particles from the mass, and thereby improve its crumb-structure. The more often the condition changes from one to the other, the finer will become the granules, other conditions being favorable. A continued wet or dry state is unfavorable to crumb-structure of soils. Freezing has a good effect in that it breaks up the coarse particles. The water, on freezing in the spaces between the particles, expands, thus separating and breaking them up, whereby the granular structure is improved. Ploughing and cultivating, if done when the soil is neither too dry nor too wet, has a good effect on granular structure. The application of organic matter will also greatly improve soil-structure, and make clay soils lighter and more porous; therefore, it should always be supplied in abundance. (See section on green crop manures later.)

Preparation of the Soil.

It is essential that soil for tobacco growing should be deeply broken and well pulverized. Where small quantities of fertilizer are to be used, the rows should be laid off 3½ feet apart by means of a single-furrow plough. Narrower rows would make cultivation tedious, especially after the plants have grown to a considerable size. For this reason some growers prefer the rows 4 feet apart. In such cases it is advisable to set the individual plants in each row closer—say, 2 feet apart.

The first furrow over which plants are to be set should have the fertilizer drilled in, and then should be subsoiled, especially if the subsoil is of a stiff nature, care being taken not to bring any of the subsoil to the surface. Where subsoiling was done in the manner suggested, it was demonstrated that the main tap roots struck deeper, making the plant more drought-resistant. It has been shown conclusively also by experiment that, where the fertilizer is placed in drills directly under the plants they get away sooner, grow faster, and ripen several weeks earlier than when the fertilizer was broadcasted.

After the fertilizer has been drilled in, the furrow will have to be refilled or covered. This can be done to suit circumstances prevailing in different climates. In wet districts, in fields that are not well drained, this furrow should be covered by ploughing two furrows from each side to form a slight ridge over the fertilized furrow. This ridge can be levelled down slightly on top by drawing a pole at right angles over it. This pole may be long enough to decap several of the ridges at one time. They can also be levelled down by passing over of a harrow,

to the tines of which a board has been attached crosswise to act as a grader. The next step is to mark the places where the plants are to be set. This can be done with a hoe. Where the plants are to be set below the surface of the ground, a small quantity of earth is drawn out so as to afford shelter, and permit the roots to set deeper, as may be required in drier regions. Another method of marking is to attach two or more chains to a pole, so that when the chains are drawn crosswise, and at right angles to the ridges, the position of the plants will be marked by parallel lines. This method is used also where it has been decided to plant on the flat or level, and no ridges are required. The rows may also be marked in this manner. The chains are placed from 2 to 3 feet apart, according to the distance required in each individual case. This method facilitates rapid dropping and transplanting. The commonest means adopted by farmers is to stretch a cord or thin wire to mark the rows, and simply guess the distance between the plants. With a little practice one is soon able to judge the distance fairly correctly.

In all tobacco soils a plentiful supply of vegetable manure should be provided, either by green crops ploughed in at least six weeks before planting time, or by liberal dressings of stable manure which has been previously well decomposed

Climatic Conditions.

Soil containing only a moderate amount of moisture is suited to tobacco of the best quality. Excessively wet soil produces coarse tobacco, which cannot be cured yellow. Moderately warm weather and moist soil, with a relatively humid atmosphere, are conducive to the healthy growth and maturity of the plant. Too wet a soil injures quality and retards maturity. Soil in such a condition becomes "packed," and excludes the air which is essential to the production of good leaf. Moderate drought is preferable to excessive moisture for fine yellow tobacco.

In dry seasons or localities moderate irrigation will often mean the salvation of the crop. In fact, few districts can really say they would not benefit at some stage of the crop's growth by the artificial application of water. But it will be readily seen from the previous remarks that judicious handling of such water is most important, both as regards the quantity and the manner in which it is to be applied. Furrows should be made between the rows of tobacco, down which a moderate amount of water can be run, just sufficient to moisten, but not saturate, the soil. Where soils are inclined to pack tightly very little should be used, or otherwise root development is prevented. The use of water in this manner is also very beneficial for transplanting in dry seasons. In all cases where irrigation is resorted to, cultivation must not be neglected immediately afterwards.

Raising of Plants.

A piece of rich, well-drained, friable land, near a supply of water if possible, should be chosen for seed beds, and due consideration be given also to the fact that tobacco must have sunshine. The young plants need the full sun all day. In this country a north-easterly slope would be best, as there plants would get the early morning sun. This, besides having a strengthening effect, would dry off any moisture or dew deposited during the night, thereby reducing favorable conditions for blue mould and other parasitic diseases.

New land is the best for the purpose. It is often found advantageous to burn the ground upon which the seed beds are to be made by piling upon it logs and brushwood sufficient, when burned, to heat the soil enough to kill all weed seed, disease spores, &c., to a depth of 3 or 4 inches.

When the fire has burned down, rake off all large charcoal and other trash, leaving the ashes to be dug in, together with a large quantity of well-rotted stable manure, and some good complete fertilizer at the rate of 1 lb. per square yard. After the soil has been well pulverized, made into a very fine tilth, and levelled on the surface, set out the beds 3 feet wide by any convenient length. The amount of seed required will vary according to the weather conditions prevailing at the time of germination. In some localities 1 ounce, which is equivalent to about one heaped tablespoonful, is sufficient for 100 square yards of bed, but in other parts twice this quantity is often used. The seed may be mixed with sufficient wood ashes or fertilizer to go over the bed twice. It may be sown by hand, first lengthwise and then crosswise, so as to ensure even distribution. The surface of the bed should then be lightly brushed over with a broom, or patted down with a board, and watered thoroughly with a fine rose sprinkler. It is a good plan to sieve some fine chaffy horse manure over the bed, covering the surface to a depth of a quarter of an inch. This mulching will keep the germinating seed warm, and prevent evaporation and drying of the surface of the bed, it being most important for the surface to be kept moist until the plants are up. If allowed to dry out during the process of germination, the seed or tiny plants will perish. It is advisable to cover the beds with cheese-cloth, grass, straw, hessian, or other suitable material to protect them from frosts. These covers should be removed in the early morning, and replaced in the evening. In cases where the surface of the beds becomes hard, it is a good plan to loosen it by inserting a spading fork, and slightly prising the surface all over. After this the beds must be thoroughly watered. At this stage liquid manure can be used to advantage, as it will find its way down the fork holes to the roots. The beds should be kept free from weeds. Tobacco plants should not be grown too thick in the beds—one plant to every square inch is quite enough. Thickly sown beds suffer more from disease than those in which plenty of room is given each plant. In cases where insects, worms, and grubs are troublesome, paris green or arsenate of lead, mixed with corn meal, may be dusted over the plants, or may be applied by means of a spray.

The sowing of seed should commence about the middle of August, and should be finished by the middle of October. It is a good plan to grow twice as many plants as it is estimated will be required. This will permit of the grower selecting the best, and only the best should be transplanted. Late-sown plants have a better chance of escaping the mould than those sown earlier.

Transplanting.

When the plants in the beds are from 4 to 6 inches high, they are large enough to be transplanted into the field. It is not a good practice to transplant while the plants are still young and tender; they take better, grow faster, and mature earlier if allowed to become strong and stalky before they are removed from the bed. The beds are usually softened by a thorough watering before the plants are drawn. They should be lifted from the soil with as little breaking and damaging of

the roots as possible. Sometimes in very hard soils it is found necessary to use a hand fork to facilitate removal. When such hard ground is met with, the surface may be pricked and prised with a garden fork to a depth of 4 or 5 inches before watering, to allow free percolation.

It is desirable to have the plants as uniform in size as possible when transplanting, the aim being to have even growth and even maturing. After being drawn from the bed the plants should not be exposed to the sun before planting, but should be placed evenly in boxes and kept well shaded. The person dropping should not proceed more than a few plants ahead of the one planting, thus limiting exposure to a minute or two when the weather is hot. A good plan is for the planter to start with an extra plant in the hand, which is planted at the first mark or hill, then while on his way to the next pick up the one which the dropper has dropped. While passing from the first to the second hill, the planter adjusts the plant in his hand ready for insertion into the hole, which he quickly makes with his trowel or dibber (a piece of wood 1½ inches thick, of suitable length and sharpened at one end). This dibber is the most useful utensil for perfect and rapid transplanting. It is inserted into the soil to a depth conforming to the length of the roots of the plant which is about to be set. After planting, the dibber is inserted around the plant several times, and by pressing the soil tightly to the roots by both dibber and the fingers of the left hand, the roots are brought into very close contact with the soil. This process is necessary in order that the roots can obtain moisture needed to sustain the plant until new rootlets are developed and the plant re-establishes itself. In favorable weather this will commence within a few hours after the plants are set. Under dry conditions it is sometimes found necessary to assist the plants by covering them with grass, or paper squares about 5 x 7 inches, the paper being placed over the plants in the form of a hood or roof, and held in position by a clod or some loose earth placed on each of two edges.

After the plants have "struck," the covers are removed, or a hole is made in the cover through which the plant grows. It is advisable to place the plants deeper in the soil in the field than they originally were in the bed, but not deep enough to cover the centre bud. The roots must be straight, and not bent or crumpled up in the hole in which they are planted.

If the weather is such that watering is necessary, one or two dibber holes should be left close to the roots, into which a pint or so of water may be poured. When the water has been absorbed by the soil, the holes should be filled by drawing dry earth into them and around the plant by means of a hoe or the hand. On no account should any holes be left open around the plant, as this greatly facilitates evaporation and impairs the health of the plant. Dry earth will act as a mulch, and prevent hardening and cracking as well as evaporation of moisture from the soil.

If the soil has been fallowed early in the autumn, and subsequently cultivated after each rain (where this is permissible in the early spring), it should be in sufficiently moist condition to sustain the plant without hand watering. Covering is preferable to watering if the soil is moist but the weather hot. However, if the soil is at all dry, the plants should be watered, as it makes them much more at home in their new quarters. If they are not watered, great care must be taken to ensure close contact of the roots with the soil. This is effectually accomplished

sometimes by pressure of the foot on the soil on at least two sides of the plant. Plants not in close contact with the soil usually die.

Machine planting is largely adopted in Victoria, and is found very efficient where the soil is in good condition and the weather not dry. Sandy soils, which are naturally free of clods and without stones, are better suited to the use of machines; but these should not be used on soils containing clods, stones, or rubbish. There are two makes of planting machines on the market—the "Bemis," which is an American production, and a local one, manufactured by Mr. Albert Smith, engineer, of Wangaratta, Victoria. Both of these machines are made on the same principle. Both are drawn by two horses, and operated by three persons, one driving, one placing the plants in the furrow, holding it in position until it is watered and gripped by the earth, while the other keeps the planter supplied with plants, which he takes from a box or other suitable receptacle on his knee. Where the roots of the plants are found to be too long for the depth of the furrow, it will be found necessary to cut them to prevent crumpling. This crumpling of roots results in stunted or dwarfed plants. The machine shear should be set as deep as possible in the ground, and the mould boards set so that they will pack the dirt tightly around the roots. These machines are fitted with attachments for watering and fertilizing. The amount of water or fertilizer can be regulated to suit circumstances. If the weather is very dry, it is well to press the soil close to the roots with the foot in a second operation after the plants have been transplanted, and it may even be found advantageous to cover the plants, as in the case of those hand planted, when such conditions prevail.

Cultivation.

As soon as the plants have struck and show signs of fresh growth by standing erect, it is time to commence cultivation. The first step is to hoe immediately around the plant, loosening the soil without cutting or disturbing the roots. This hoeing should be followed by the Planet Junior, or other horse cultivator, in between the rows, to break and loosen the surface soil, and form a mulch to prevent evaporation of moisture.

It is a good practice to plough between the rows, especially in the case of loamy soils, first away from the plants, then back to them. At first this ploughing should be fairly deep; later shallow work should be done. While this process is proceeding and the soil is thrown away from each side of the rows, the plants are left standing on a narrow strip of land, which is next hoed free of weeds. Then the soil is thrown back by the plough towards the plants, forming a slight ridge; finally it is drawn up around them with a hoe. Though practically all the cultivation is done by a fine cultivator, I have found the plough the cheapest and most thorough implement for cleaning the soil of weeds.

No crop responds more readily to clean cultivation than tobacco. By continuous cultivation the crop can usually be kept growing. Continuous and unhampered growth is very necessary for the production of first grade tobacco of any type. If cultivation is neglected the yield will be curtailed and the quality impaired. During the last cultivation any plants which have been blown over by wind should be straightened and supported.

Topping.

In sandy soils, the fewer the leaves left on the plant to ripen, within certain limits, the greater will be the development, and the sweeter and richer will be the tobacco. Yet, on rich heavy soils plants with only a few leaves will grow large ribs, coarse veins, and a thick-textured leaf, which will smoke better and have an objectionable aroma. One of the best rules to follow, I think, is to leave from ten to twelve leaves on plants grown on soils which have herein been termed "sandy," and from ten to fifteen on those termed "loam" soils, the number varying with the fertility of the soil. On heavy river flats, where the soil is more or less of a silty, clayey nature, even more than the maximum number named may be left. This will tend to reduce coarseness.

Topping is done by pinching out the top of the stem bearing the flower bud, leaving the desired number of leaves to mature. The bottom or "sand" leaves are not included in this number. The usual method of counting the leaves to be left on the plant is to fix the eye upon the lowest good leaf, ignoring the bottom trashy ones, and for every leaf over such good leaf reckon three—thus, five leaves over each other would amount to fifteen, including the top and bottom ones. This method expedites the work of topping.

As to the advisability of priming the trashy bottom leaves off the plant, there is much diversity of opinion. Some prefer priming for admission of light and warmth, believing it promotes early maturity. Other growers prefer to leave the bottom leaves to protect the better leaves from being splashed with mud during heavy rain. Very often these bottom leaves are good, and when cured prove to be an article of fair value. It is a common practice to top the plant as soon as a sufficient number of leaves are showing, or at such time when the centre seed bud makes its appearance. It is a good plan, however, to just nip the bud out at first and then watch the weather conditions. If these are warm and moist they will favour the development of a large number of leaves; if on the contrary they are dry or unfavorable to the growth of a large number of leaves, the plants are retopped a few leaves lower. For the production of leaf of good size and quality, especially on light sandy soils, it is not advisable to leave more than fourteen leaves to the plant. The best results are obtained when only ten or twelve leaves are produced on the fair average plant, this number not including the three or four bottom or sand leaves, which may be gathered at or shortly after topping. If sound, the best of these bottom leaves can be hung in the barn and cured.

As some plants are capable of carrying and maturing more leaves than others, the grower must decide how many to leave on, for he alone knows the capacity of his soil and the conditions which generally prevail in his particular district. The general appearance of individual plants suggests data regarding the possible capacity of the plant and the fertility of the soil upon which they are grown.

Suckering.

Shortly after topping, suckers will make their appearance at the axis of the leaves. These must be promptly pinched out while they are still young and tender. If left they become tough and woody, and develop at the expense of the other leaves. Two suckers will be produced successively at the base of each leaf. Usually the plants have

to be gone over two or three times; the first time, only those nearest the top being long enough to handle. The second suckering will deal with those of the leaves lower down, and the third with those from the top leaves again. The number of suckerings depends largely upon the fertility of the soil and the consequent tendency to rankness. However, there is consolation in the dictum—"The more suckering, the more tobacco." By topping and suckering the vitality of the plant is concentrated in the development of the leaf.

(To be continued.)

WHY CREAM TESTS VARY.

By R. T. McKenzie, Senior Dairy Supervisor.

Very few dairymen throughout the State appear to be satisfied with the butter-fat test of cream supplied to the factory.

It has been my experience over several years that, because of the frequent variation of the test, many of them think they are not getting a "fair deal." They ask why should the test vary when the conditions under which the cream is produced remain the same from day to day. The same cows are milked, the feed is the same, and the cream screw of the separator remains unaltered! As a matter of fact, if the test remained the same from week to week, it should arouse suspicion as to the accuracy of the testing. Cream does vary in richness of fat, and, because many dairymen do not quite understand the causes of this variation, misunderstandings arise between supplier and factory. The variations do not indicate wrong testing; they are due to causes over which the factory tester has no control.

There are several factors in the separation of milk that cause variation of the cream test, and dairymen should examine these before doubting the authenticity of factory returns.

In the first place, the separator should be placed on a firm and solid foundation and set perfectly level. If this is not done, the working parts soon get thrown out of balance, as the machine revolves during the skimming process. Smooth running ensures the skim milk and cream flowing freely to their respective outlets. If there be any vibration the milk and cream get shaken together, resulting in imperfect separation. Perfect separation should leave a residue of not more than .029 of fat in the skim milk.

In the manipulation of the separator it is important that the crank should be turned the correct number of times per minute. Instructions are given with every machine as to the speed the handle should be turned to obtain the best results; these instructions should be closely followed. A change of speed changes the percentage of butter-fat in the cream. If the machine be speeded to a greater extent than the speed set by the maker, there is a greater amount of skim milk thrown out, resulting in a smaller amount of high-testing cream. On the other

hand, a slower speed of the bowl throws out less skim milk and a larger amount of thinner cream. If the speed of the bowl is much below the normal rate the cream will be imperfectly separated from the milk serum, as some of the fat will pass into the skim milk. These are important factors in causing a variation in the cream test. The rate of inflow of milk into the bowl may also cause a varying test. Every machine is set to a certain capacity per hour, and it is assumed that the milk flows at the same rate because of the float regulating the inflow into the bowl, but sometimes the tank is allowed to get low, or the faucet may not be opened to its full capacity, with the result that the amount of milk flowing into the bowl is decreased. If the flow of milk into the bowl be decreased, a richer cream will be thrown out. Variation in the richness of the milk of the herd causes a variation of the cream test. At certain times of the year, particularly in the autumn, the milk is richer, and if there be no alteration of the cream screw of the separator, the test should be higher than other times of the year.

There are many other factors that influence the milk test of the herd, such as sexual disturbances. A cow in season will drop as much as 4 per cent. in her test, and, if there are several such cases, it will considerably lower the average cream test of the whole herd. A sudden change in the weather, a complete change of feed, in fact excitement of any kind, will affect the milk test, with a consequent change in the cream test. The temperature of milk when separated will affect the cream test. Warm milk will flow more readily and separate easier than cold milk. Milk below a temperature of 80° F. will not separate satisfactorily. The heat at which it is drawn from the cow, i.e., 90° F., is the most suitable temperature at which to separate. Cold milk does not separate readily, owing to its more viscous state, the cold cream clogging the separator, with a consequent loss of fat into the skim milk.

Flushing the bowl is a common cause of varying cream tests, because variation of the amount of water or skim milk may appreciably alter the yield of cream. It is easy enough to vary a pint or so in the amount used, and this may vary the test from 2 to 5 per cent., according to the quantity of cream separated. The identical amount of flushing water should be used on each occasion to get even results. Cleanliness in every detail of the separator is essential to get even results. The richness of cream is readily governed by the cream screw, but, as dairymen do not tinker frequently with that portion of the machine, this factor may be regarded as a negligible cause in the varying test. The cream screw should be operated to produce the test of the cream between 40 and 50 per cent. Skim milk left in the cream causes quick souring.

I have had many discussions with dairymen regarding the varying cream tests, and it is really surprising the small number, even of experienced dairymen, who are acquainted with the many causes of this variation. It remains, then, for all dairymen to consider the reasons suggested. They will find, in most cases, that the trouble lies not in inaccurate or dishonest tests at the factory, but in conditions over which the factory tester has no control.

ORCHARD AND GARDEN NOTES.

E. E. Pescott, F.L.S., Pomologist.

The Orchard.

PRUNING.

Pruning operations will now be in full swing. In pruning the young trees, heavy pruning will be required in order to produce strong growths and a good frame, but as the tree advances in age the pruning will be reduced considerably. It should be remembered that strong, heavy pruning results in wood growth, and that weak pruning steadies the tree, and promotes an even growth. When framing and building a tree, the former consideration is observed, and when the tree is coming into fruit bearing or is mature, it will be pruned according to the latter. Any operation that will cause the tree to produce less wood growth will induce the tree to become more fruitful, provided the tree be in a healthy condition; so that when trees are mature, pruning operations, as a rule, should not be severe, but rather the reverse.

Old fruiting wood, and dead and dying wood should always be removed, and aged spurs should be considerably reduced, in order to make them produce new growths. Crowded and overlapping laterals should be shortened back; fruit-bearing in the higher portions of the tree should not be encouraged; and due consideration should be given to the admission of light and air to all parts of the tree.

Where varieties of fruit trees are prone to bearing crops every second year, their lateral system should be pruned so that they will not produce too heavy a crop in the fruiting year; and at the same time they will produce wood in their fruiting year to give a crop in the subsequent season.

A model tree will always be light on its topmost leaders, bearing the major portions of the crop in the lower regions of the tree. The main point to be noted is that a heavy wood growth in the upper portion of the tree tends to reduce the bearing capabilities of the tree in its most useful parts.

DRAINAGE.

The rains of winter will always show the necessity for draining orchards. Where under-soil drains do not exist, the trees are bound to suffer. If the damage is not immediately apparent, it will be later found that in some way loss will accrue. Either the tree will be weakened by the loss of roots through rotting, or it will be devitalized so that it will not carry a satisfactory crop of fruit. Too often surface drainage is relied on to remove the so-called surplus water. There should be no surplus water for surface drains. The water is only surplus or excess when it is in the soil. Two circumstances, and two only, permit of surface drainage. First, when it is necessary to carry away excessive stormwater; and, second, when it is practically impossible to find an outlet for under-drains, owing to the low-lying situation of the area.

The term "surface drainage" does not apply to open drains, which, owing to their depth, act also as soil drains; neither does it apply to graded surfaces which allow a more equitable distribution of water. Surface draining is usually applied to a system, whereby a considerable

quantity of water is removed by gravitation before it enters the soil. Such a system cannot be too roundly condemned. As much water as can be obtained by natural means should be induced to enter orchard soils; and then whatever is in excess will be carried away by under drainage, provided that drainage, either natural or artificial, be in existence.

Where suitable drainage is not provided, the tree roots are compelled to remain in a few inches of surface soil. Their feeding area is thus extremely limited indeed; and when, at any time, rain-water does filter and penetrate through the soil, it carries with it the soluble and other plant foods, below the reach of the tree roots.

Soil ventilation is only possible with a system of drainage, and air is as necessary to the roots of a tree as it is to the foliage. By the removal of the surplus water and the consequent admission of air into the soil, the soil temperature is rendered far more equable, warmer in winter and spring, and cooler in summer; and such a change must be beneficial to the trees.

Drainage is thus an essential for all orchard lands. When natural drainage occurs, the orchardist is fortunate; but whether natural or artificial, a system of drainage will always materially increase the crop of fruit, strengthen the trees, and considerably add to their term of life.

Drainage schemes should be carried out at the present season of the year. In closed drains, such drainage media as cinders, charcoal, stones, brushwood, timber, logs, or tile pipes may be used, but the latter generally give more satisfactory and permanent results. They are also less liable to silting up than any other material.

Drains should be placed into the clay, if this be not too deep. In any case, they should be below any possible interference from cultivating instruments.

SPRAYING.

In order to keep in check such pests as Bryobia, scale insects, woolly aphis, and others, a strong and forcible spraying with lime sulphur, nicotine—sulphate or red oil spray should not be delayed any longer. The whole tree should be thoroughly wetted with the spray. A good, vigorous, and thorough winter spraying will place a large majority of the trees in quite a satisfactory condition of freedom from these pests for the whole year.

The lime sulphur spray is an excellent fungicide, and a strong winter spray will go a very long way in reducing any attack of the black spot fungus on either the apple or the pear. In addition, if the peach trees are sprayed at this time with lime sulphur, both peach aphis and peach leaf curl will be considerably minimised in the spring time.

The Flower Garden.

Digging in the garden should be continued. Before digging, the beds should be given a top dressing of lime or stable manure, and subsequently these should be dug well into the soil. Care must be taken not to injure the roots of any shrubs, trees, or roses. Root cutting and root pruning will always dwarf any plant. In digging, it is not wise to discard any leaves, twiggy growths, or weeds. Unless they are required for the compost heap they should always be dug into the soil.

Leaf-mould is especially useful in any garden, and where such plants as Azaleas, Rhododendrons, Paeonies, Liliums, &c., are grown, or for pot-plant work, it is exceedingly valuable. In forming the compost heap, no medium whatever should be added to help the rotting down of the leaves unless it be a little sand. Any chemical added will render the mould unsuitable for its special objects. The plants mentioned above strongly object to lime.

All shrubs that produce flowers on their young growths, including roses, should now be pruned. Care should be taken to distinguish between those shrubs that flower on the new wood and those that flower on the wood of the past season's growth. Those that flower on the new wood, and may now be pruned, are Lantana, Cestrum, Tecoma, Hydrangea, Plumbago, Erythrina (some species), &c., and those that should not be touched at present time are Spirea, Erythrina (some species), Pyrus Japonica, Weigelia, Prunus pissardi, P. Vesuvius, P. mume, Deutzia, Polygala, Ceanothus, &c. It is a safe rule in pruning shrubs to wait until they have flowered before pruning. This will certainly give the shrubs a somewhat ragged appearance in the winter, but it is the only way to secure the best flowering results.

All herbaceous plants, such as Salvia, Aster, Delphinium, Polygonum, Boltonia, Gaura, and Chrysanthemum, should be cut back, and, if necessary, lifted and "heeled in" in a temporary location for the winter. Plant out early Gladioli, Iris, and Liliums.

Continue digging, manuring, and trenching.

The Vegetable Garden.

Seedlings from boxes or seed plots may now be planted out. Care should be taken that all vegetable beds are well raised and thrown up. By throwing up the soil, and thus deepening the paths and the spaces between the plots, the latter are well drained, and the soil is made considerably warmer. This will greatly facilitate the growth of the young plants.

Asparagus may be planted; sow seeds of carrots, parsnips, cauliflowers, onions, peas, broad beans, and tomatoes, the latter being forced on in a frame, so as to obtain good plants quickly.

REMINDERS FOR AUGUST.

LIVE STOCK.

HORSES.—The feeding and general management of horses recommended for July will also apply for this month. Horses, more especially young ones, running on low-lying country are liable to become affected with internal parasites. This will be recognised by the unthrifty and poor condition of the animals; in such cases medicinal treatment will be necessary. If the following lick be made available, it will not only be of great assistance in preventing serious invasion, but in cases where worms are not in large numbers, the repulsion of them from the intestinal tract will result:—

Lick.

20 parts salt.
10 do. lime.
1 do. sulphate of iron.

If possible, be with mares at foaling, so that the navel cord may be properly tied and thoroughly treated with antiseptic, and thus prevent that very fatal disease, navel or joint ill. Wash cord with one part of corrosive sublimate to 3,000 of water, and soon after paint with tincture of iodine. The iodine treatment must continue till the cord has completely dried up.

CATTLE.—Cows should still be rugged, but coverings should be removed frequently, in order to enable the animal to get rid of the old coat; or, better still, a good curry-combing may be given. Continue hay or straw. Look up treatment for milk fever in *Journal of Agriculture, Nov.*, 1922 and treat cattle accordingly. Give calves a good warm dry shed. Give the milk to young calves at blood heat. Have feeding troughs or buckets clean. Don't over-feed. Feed regularly with regard to quantity and time. Provide a good grass run, or fine hay or crushed oats in a box or trough. Give a cupful of limewater per calf per day in the milk. The problem with many at the present time is how to rear calves without milk. This can be done very well by starting them on new milk for a fortnight, and then gradually substituting the milk with one of the calf meals on the market. To these it would be advisable to add two or three tablespoonfuls of cod liver oil. The following meal is in general use in Ireland:—Two parts, by weight, of oatmeal, 2 parts maize meal, 1 part pure ground linseed, all finely ground. Scald with boiling water, and allow to stand for twelve hours. Start with new milk, then gradually substitute skim and ¼ lb. daily of the meal mixture per head per day, gradually increasing to 1 lb. or more. In a month milk may be dispensed with altogether. The crushed oats, fed dry, have been found to give excellent results.

PIGS.—Supply plenty of bedding in warm well-ventilated sties. Keep sties clean and dry, and feeding troughs clean and wholesome. Sows may now be turned into grass run. If pigs are lousy dress with kerosene emulsion or sulphur and lard, rubbing well into crevices of skin, and disinfect sties. Worms are very prevalent at present, and may be treated by giving 2 to 10 grains of Santonin in form of pill, or from half to one teaspoonful of oil of turpentine in milk or castor oil.

SHEEP.—Decide on the breed and number of rams required for the coming season. Place orders as soon as possible. Breeders can then give better satisfaction, and allot preference to the earlier applications. The result of mating should be given most careful consideration from both wool and mutton points of view. Evidence points to a shortage of good merino and fine crossbred wool for years to come. At the same time, a steady demand has set in for materials manufactured from these finer grades. After all, coarse common wools have a limited use. Cull stud ewes carefully, especially merinoes, consider form as well as evenness of covering and style of wool. Discard for thin fribby forearms, for coarse common thighs, for mushy wasty undercovering, inferior patches across the shoulders, common and short between the hip bones. Individual merit must be considered first, pedigree alone is not sufficient.

CULTIVATION.

FARM.—Second fallow where necessary for summer crops. If required, roll or harrow crops. Plant very early potatoes in forward districts. Sow mangolds. Apply slow-acting fertilizers, such as blood and bone manures, for maize.

VINEYARD.—August is the best month for planting vines (grafted or ungrafted). This should be actively proceeded with and completed before end of month. Scions for field grafting may still be preserved as detailed last month, or better still by placing them in cool storage. They should all be removed from vines before end of month, at latest. Conclude pruning and tie down rods. Where black spot has been prevalent, apply first acid iron sulphate treatment. Owing to the dry spring, black spot was not in evidence last season. The fungus is not dead, but dormant, hence preventive treatment must not be neglected. Leaflets dealing with black spot and its treatment will be supplied on application.

Cellar.—Rack again, towards end of month, wines which have as yet only been once racked (spring racking). Fill up regularly all unfortified wines. Clean up generally in cellar and whitewash walls, woodwork, &c.

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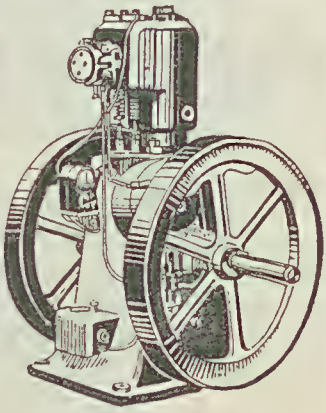

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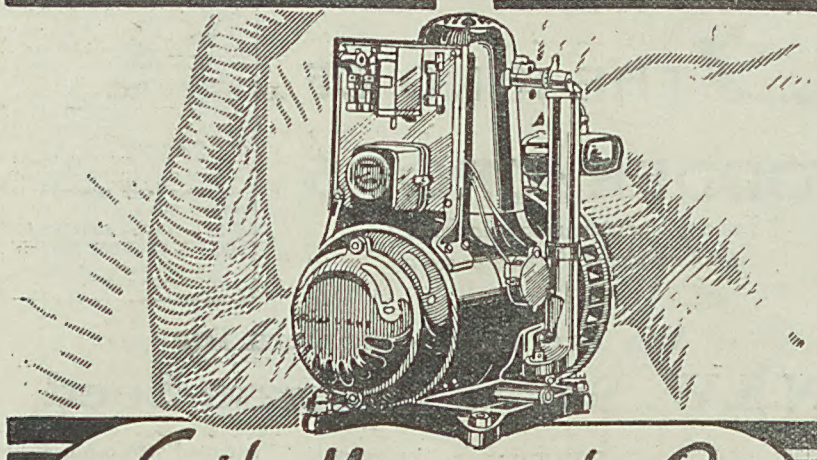

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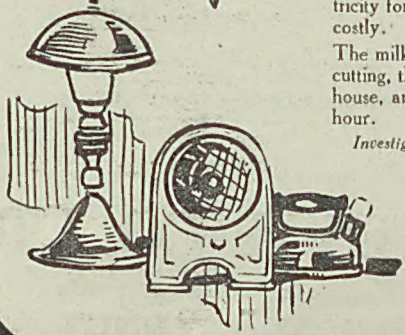

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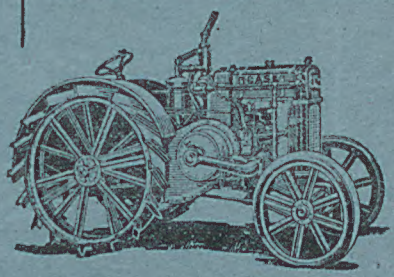

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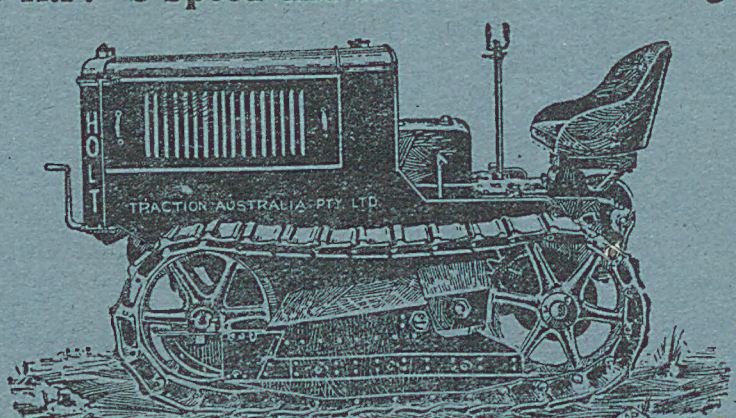

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